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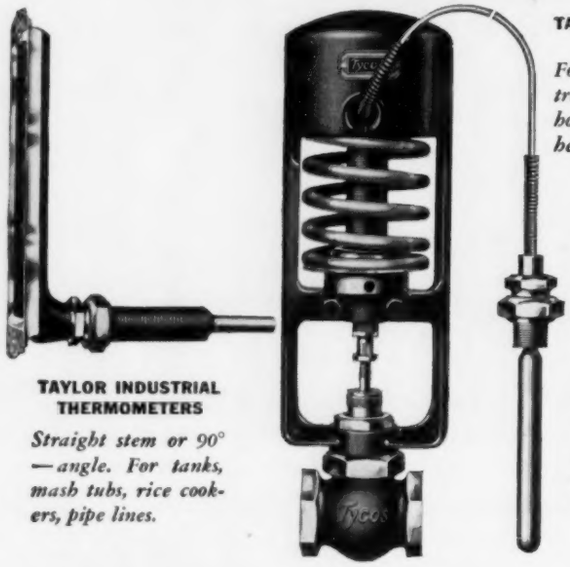
INSTRUMENTS

THE MAGAZINE OF MEASUREMENT AND CONTROL

VOLUME 6 AUGUST, 1933 NUMBER 8

CENTRALIZED CONTROL PANEL AT GLOBE OIL & REFINING CO., McPHERSON, KANSAS (*Courtesy Brown Instrument Co.*)

See Page 152



TAYLOR INDUSTRIAL THERMOMETERS

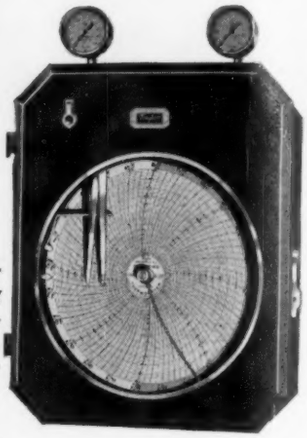
Straight stem or 90° —angle. For tanks, mash tubs, rice cookers, pipe lines.

TAYLOR SELF-ACTING REGULATOR

For temperature control on bottle soakers, hot water tanks and heaters. (at left)

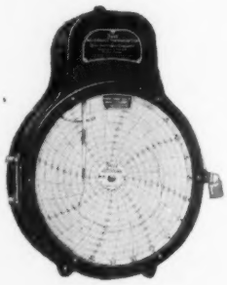
TAYLOR RECORDING TEMPERATURE REGULATOR

Most modern instrument for controlling and recording pasteurizer temperatures. (at right)



TAYLOR RECORDING THERMOMETERS

For mash tubs, sparge pipes, cookers, pasteurizers, beer kettles. (below)



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INSTRUMENTS

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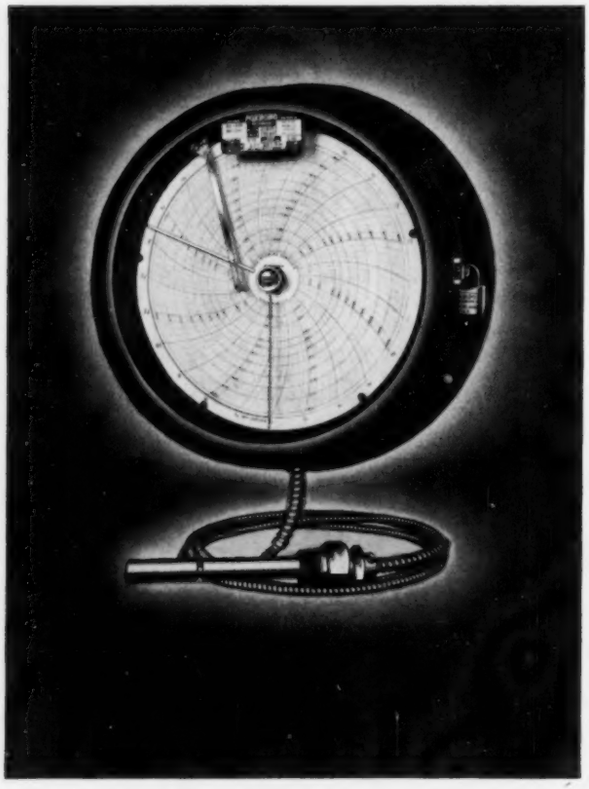
FOLLOW THE TREND

To Better Hand Control with FOXBORO RECORDING THERMOMETERS



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IN BREWERIES

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EDITORIAL COMMENT

In This Issue

♦ R. S. **Blodgett's** instructive outline of **Modern Brewery Instrumentation** not only tells about the parts played by instruments in a re-born industry which is much in the public eye, but may itself prove to be a guide to modernizing breweries even more. For example, we believe that automatic devices could lessen the strain of watching indicating and recording thermometers on hot water tanks, rice cookers, mash tuns, kettles, coolers and even fermenting and storage tanks in many breweries. In addition, this article may give ideas to our readers in industries totally different from that which is discussed.

♦ Four more classes of control devices for fractional-horsepower motors are described by **F. L. Spangler** this month: two classes of overload relays, remote control and photoelectric control. This instalment concludes the series.

♦ In this month's instalment of the book on fluid meters, industrial types of **Bellows Gas Meters** are discussed.

♦ The **New Instruments** section reflects the return of beer, in that it contains items on beer meters and beer-dispensing pressure regulators, but as usual it covers a wide range of fields where progress has recently been made.

◆ ◆ ◆

The Front Cover

♦ "Maximum yields in refinery processes at the lowest cost" are secured by the Globe Oil & Refining Co., we are told, with the aid of the control panel shown. This installation comprises tube still outlet oil temperature control, as well as instruments for indicating and recording fluid flow, temperatures and pressures. The "Interlock" control system is interesting: Two thermocouples in the furnace are connected to a "Trendalizer" controller which operates from one thermocouple in the oil outlet, through the "Interlock," to regulate the *average* furnace temperature as reported by the two furnace thermocouples. In other words, the oil temperature controller's function is to reset the furnace temperature controller whenever the oil temperature tends to vary. This "wrinkle" gives a good mode of control on various continuous heat-exchange processes and it "isn't as complicated as it sounds."

Save Research!

TO all axe-grinding critics of the Roosevelt régime we have turned a deaf ear. No sympathy have we toward those who complain that they will never again be able to make big profits under NIRA. On our part, we are willing to continue making sacrifices for "the greatest good of the greatest number." We realize that the Administration is fired with patriotic zeal, that all high officials are unselfishly grappling with great problems, and that they deserve support.

We and our readers are for NIRA not only as good Americans but as advocates of Instrumentation—which shorter hours will promote.

But when our hard-working new rulers in Washington make serious errors of judgment, when they slip up altogether and make decisions *against* the fundamental tenets of the New Deal, then we deem it our duty to register an indignant protest.

The New Deal—if its definitions were not empty platitudes—stands for the equitable distribution of economic blessings in a dynamic social structure, a Nation organized for steady onward progress, protected against stoppage and the "downward spiral." Its prime objective is re-employment. Every big gesture confirms this: maximum work-week and minimum wage provisions for industry, a blanket code for businesses, 300,000 new government jobs in the C.C.C., etc.

Some of these measures aim at immediate relief by transferring billions of dollars from thousands of safe-deposit boxes to millions of pay envelopes.

Other measures look to the future: plant trees, improve roads, dig canals, build dams, modernize railroads, etc., in order that when this depression is over there will be less waste of national wealth and that the nation's greater income will be more evenly spread among a happy people kept busy developing, making, transporting and sellings things to one another, with fewer pirates and parasites to support.

Members of the so-called Brain Trust have laid emphasis on the *creation of future employment.* Best of all because practical, understandable and hence realizable by reason of ungrudging support!

Of all creators of future employment research workers are the most effective. Everything in our present scale of living which differentiates us from Hottentots is the product of yesterday's Research. Most of what we shall wear, eat, live in, ride in, fly in, communicate with and play with to-morrow will have been the product of today's Research.

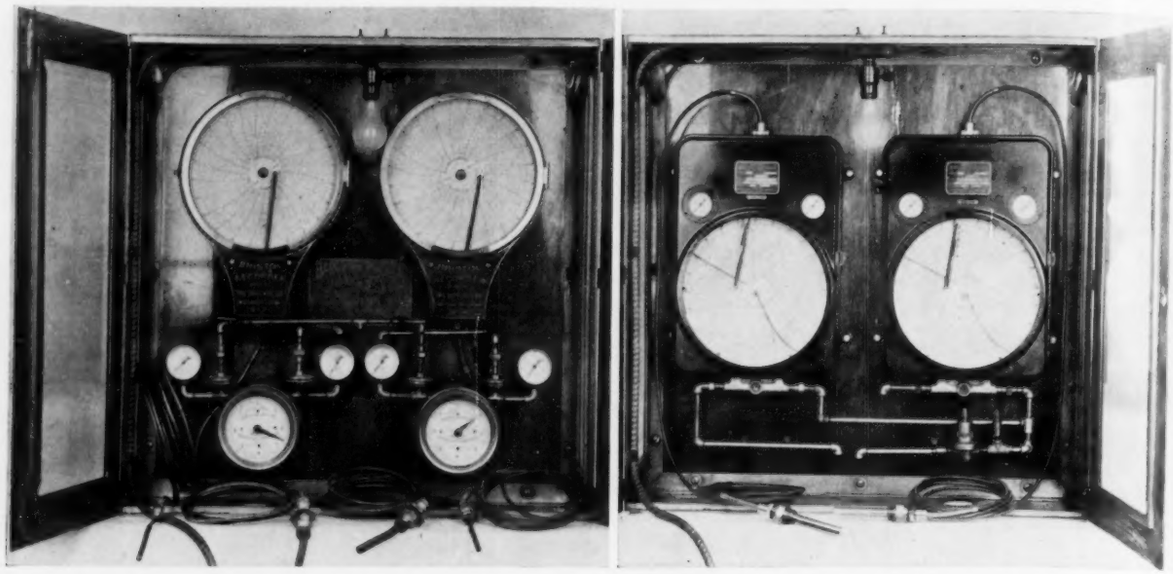
Of all publicly maintained research institutions, the Bureau of Standards is the most useful. Much of America's modern greatness is due to its unheralded activities. New industries have been created and old ones re-vivified, by the fruits of its work. And now comes the news that hundreds of Bureau physicists, chemists and engineers are to be denied a chance to continue serving as creators of employment. Other Federal research institutions likewise crippled are the Bureaux of Mines and of Fisheries, and the Coast and Geodetic Survey.

If drastic economies were the inflexible rule, we would not print a line of protest; but the "saving" is a million or so and this news comes on top of announcements that *billions* will be spent on the Navy and other public works!

What constitutes a more useful "public work" than Research?

Can it be that those who denied Secretary Roper's urgent request for $450,000—less than the cost of making the blueprints for one battleship—are of the opinion that a *National* bureau of standards is just a butcher scale inspection office? What in the name of common sense is the idea of throwing out of work hundreds of this nation's most useful work-creators as part of a program of putting idle men to work?

Crippling the Bureaux of Standards, of Mines and of Fisheries is a stupid error. We hope that this error will have been rectified before this issue of *Instruments* comes off the press in the middle of August, but it seems that there is a "blind spot" which it will probably take months of effort on the part of friends of these Bureaux to correct.



The old and the new, or "before and after" modernization. At left, a pasteurizer control cabinet just as received at the factory for repairs. Note that the equipment consists of two old 12" case recording thermometers and two old air-operated non-indicating temperature controllers. At right, the same cabinet photographed just before shipment to the brewery. Note that the brewing company, instead of ordering the old equipment repaired, demanded (and got) the latest model combination recorder-controllers. Nothing remains but the nickel-plated bronze cabinet with slate panel and plate glass windows—so handsome that it still is "modern"—and the diaphragm-motor valves on the pasteurizer.

Modern Brewery Instrumentation

By R. S. BLODGETT*

ONE of the oldest industries in the United States, dating back to early Colonial days, the brewing of beer, grew to a place of high rank among all food industries. In 1920 its natural growth was interrupted by legislation, but today, after 13 years, brewers again find themselves permitted to supply the amber fluid. This revival comes at a time when any business activity is most welcome. A great deal of attention is being given to breweries and much hope is centered in them as prospective users of new equipment.

Brewers have always been pleased to look on their industry as a scientific process. Their methods have been developed in the laboratory and they have sought to reproduce those methods in manufacture by the use of the best available equipment. The various processes have been guided by accurate measurements in scientific units.

There is a considerable tradition among brewers. Practically all of them still measure temperature in the Réaumur scale which is a relic of earlier days. But their traditions are not the kind that impede progress. In the matter of equipment they not only seek the best but have been factors in new development.

Years ago, no cooling facilities being available, beer was brewed only in the winter months. The brewing season started up in October, whence the poem on "Golden Brown October Ale." Being the first of the season, the October brew became the oldest and best. Today, with refrigerating equipment, there is no closed season for brewing. But these splendid cooling methods of today owe much to the brewing industry for it was because of their needs and through their experimentation that mechanical refrigeration was first developed.

In a good brewery you will find a well equipped laboratory in charge of a capable chemist. In the brew house you will find the brewmaster a most important figure in the industry. These two work together closely in trying to apply the scientific results of the laboratory to the manufacture on a large scale. In trying to accomplish this the brewmaster has long recognized the need of instruments to measure and guide his various processes. In his office you will find thermometer charts which record every brew as to temperature and time.

Beer is a cereal product. It is made of grain, flavored with hops, and fermented by yeast. The actual process involves so many bio-chemical changes that a consideration of it is necessary to appreciate the value of instruments. Barley is the chief constituent. The first step is to convert this grain into malt. This is done by producing an artificial germination by means of closely controlled temperature and humidity conditions. The grain starts to sprout and thereby exposes the starch which is converted to sugar. After this conversion has proceeded to the desired point the malt is thoroughly dried in kilns. The degree of drying of the malt determines the color of the beer. Thus a very fine control is necessary at this point to produce the desired color in the final product. Throughout this initial part of the process temperature, humidity and time are factors. Indicating, recording and controlling instruments all have their value.

In Germany nearly every brewery prepares its own malt from the barley. In this country very few breweries produce the malt. Malting is a specialized industry largely centered in the middle west and supplying malt to breweries all over the country.

The typical American brewery starts with the malt. The first process is to extract from it everything that is needed, in liquid form. This is carried out in the mash tub and mash cooker. The malt is first screened and then ground very fine and mixed with hot water by means of

*Engineer, The Bristol Co.

agitators. The mash tub in which this is carried on is a large covered metal vat so arranged that the ground malt, hot water, and cold water can be admitted as required. Parallel to the mash tub is the mash cooker in which a certain part of the batch, with perhaps the addition of some other grains, is cooked. This is a pressure cooker using steam and so arranged that the temperature can be closely controlled.

This process is called mashing and is a batch process. The amounts of malt and water are carefully measured. Temperature and time are closely checked. The quantity of malt is weighed by automatic scales. The addition of water is manually controlled. Both the tub and the cooker are equipped with indicating and recording thermometers. Temperature control is now manual but automatic control is a future possibility. The final test on this is to determine the concentration of the extract which is done with a saccharometer—a form of hydrometer.

When the batch has been sufficiently cooked and agitated it is sent to the filters. Here the solid matter is removed and given a secondary treatment with hot water to recover any extract which may be left. This is termed sparging. The grain residue is then removed and sold as a by-product for cattle feed. The liquid extract which is called wort is now ready for the next step.

The wort is now put into the brew kettles. These kettles are made of copper with a dome shaped top leading to an exhaust flue. They are built with either a jacket or a series of coils for the admission of steam. These kettles range in size from 50 to 700 barrels capacity each. A bank of large ones with their exteriors brightly polished present a very unique picture in the brew house.

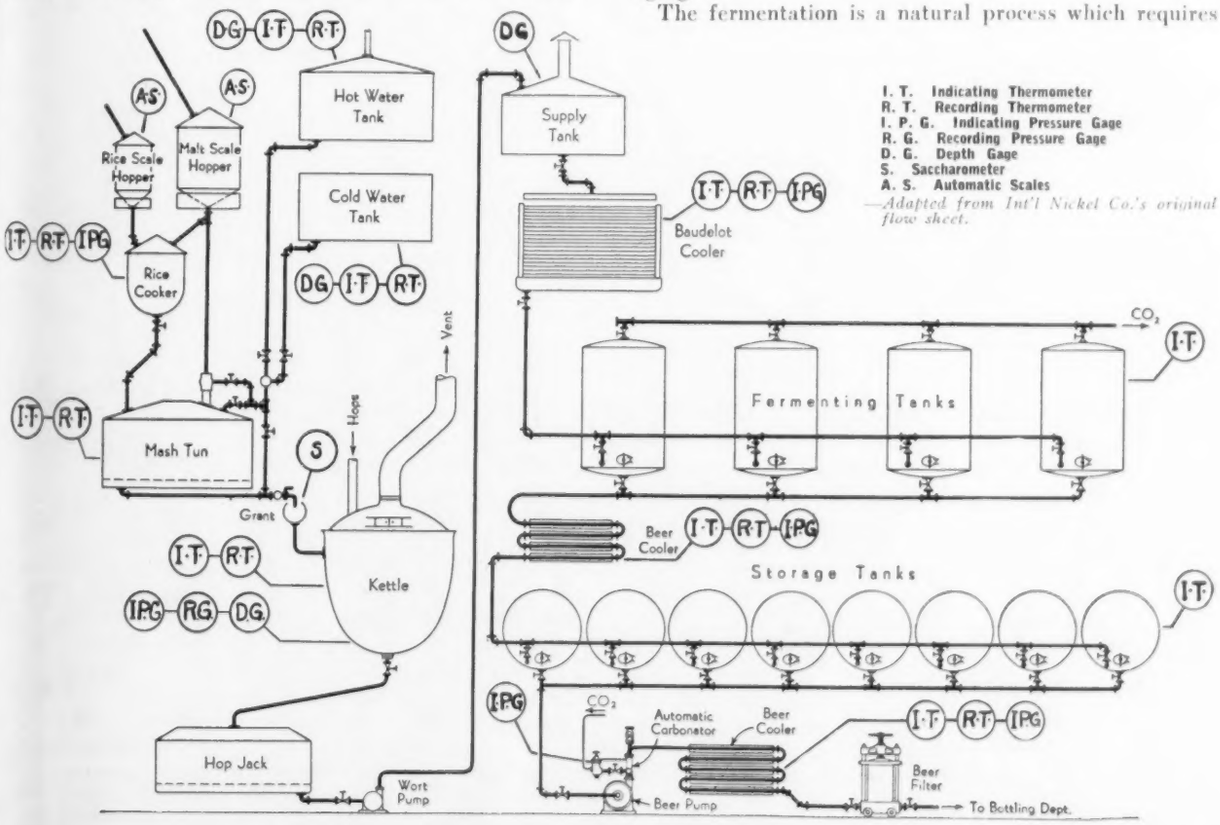
The wort is boiled in these steam heated kettles and during the boiling the hops are added to give the beer its characteristic flavor and to aid in preserving it. This process, which requires about 4 hours, precipitates the proteins, extracts the bitter principles and aromatic esters of the hops, concentrates and sterilizes the wort.

It can be seen that this brewing process must be closely regulated to secure a uniform product. The depth of the batch in the kettle is measured by a telegage and the required amount of hops is carefully weighed. Indicating thermometers are relied on by the operators and recorders maintain a temperature record of the brew. Steam gages, both indicating and recording, are used to check the pressure of the steam at the kettle. The control of this temperature on present installations is manual. Automatic control of the steam either by temperature or by both time and temperature may be used in the future as an aid to the brewmaster.

When the batch is completed the wort is removed from the bottom of the kettle and the residue of the hops is filtered out in a compartment termed the hop-jack. The liquid is carried to the wort or settling tank which partially cools it and allows some of the precipitate to settle. The wort is then circulated through the cooler. What is known as a Baudelot cooler is frequently used. In this equipment the liquid passes over the outside of a series of horizontal coils which are cooled by water or ammonia. This permits aeration of the wort which is desirable but imposes the requirement of keeping the surrounding air sterile. When it leaves the cooler at a temperature of about 45° F. it is ready for the fermentation cellar.

The cold wort first goes into the pitching vat where the proper amount of yeast is added. Here we again note the importance of the chemist for it is under his direction that the yeast has been obtained from a pure culture apparatus. The mixture is agitated and then put into the fermenters, which are large tanks usually of a size larger than the brew kettle so that a single brew will be fermented as a separate batch. These tanks in the earlier days were entirely constructed of wood properly coated so that the beer could not seep into the wood. Present day tendencies are toward metal tanks, either glass or porcelain lined or unlined. Contrary to some popular conceptions wood does not improve beer in fermenting or aging.

The fermentation is a natural process which requires



—*Adapted from Int'l Nickel Co.'s original flow sheet.*

only the maintenance of favorable temperature conditions. It converts the sugar into alcohol with carbon dioxide gas resulting. This gas is collected and later used to carbonate the beer before bottling or racking it. The fermentation period is for about one week after which the beer is placed in the aging tanks. These are similar to the fermentation tanks and here again the temperature is maintained uniformly.

The cooling of brewing cellars is accomplished either by the circulation of a refrigerant through a series of pipes in the cellar or by conditioning the air outside and blowing it through. Another method used is to cool each tank individually by the circulation of a refrigerating fluid through a specially constructed jacket around the tank. With any system a liberal allotment of thermometers is necessary to guide the engineer in his task of maintaining the necessary cool temperature.

The period of aging the beer varies somewhat but the best brewers insist on 2 or 3 months. The aging process also permits settling. In earlier days this was required to clear the product. Today an adequate filter system is used to completely clarify it. After the beer is removed from the tanks it is passed through the automatic carbonator where the carbon dioxide is returned to it. It then passes through the final filter and is ready to be prepared for distribution.

A landmark of New York—the Ruppert Brewery's "hall of kettles" where visitors admire gleaming metal, marble walls . . . and instruments.

Beer which is sold for draught is put into quarter barrels and half barrels. A barrel in the brewing industry is 31 gallons. These barrels or kegs are traditionally of wood. Inasmuch as wood is not essential we find metal kegs now coming into use. The filling of kegs is termed racking. This process of course includes the washing and sterilization by steam of the empty kegs before they are filled. This is much simpler in operation than is the bottling process.

The bottling department is located in a building separate from the brewery. A considerable amount of equipment and labor is required to operate this. First the incoming bottles are removed from the cases. The cases are cleaned by hand and the bottles placed in the automatic washer. They are first soaked and then passed between brushes which remove the labels and clean them. Next they are sterilized with hot water, then cooled and dried.

Temperature control on these bottle washers is important. The bottle goes in at room temperature and comes out cold. In between it has been subjected to boiling water. These changes cannot be too sudden or breakage will result.

From the washer the clean and cooled bottles are carried to the automatic filling and crowning machine. Here they are filled with the cold beer and capped. By an endless conveyor they are now carried to the pasteurizer.

Pasteurization of the beer consists in passing the bottles through a hot water bath which brings the temperature up to about 145° F. The purpose of this is to kill any bacteria which may remain and thereby check any further fermentation. The temperature here is very critical just as it is in the same process with milk, and for the same reasons. In both cases the temperature must be brought up to a certain minimum to accomplish the elimination of bacteria but too high a temperature will have the effect of impairing the taste or appearance of the product.

A usual type of brewery pasteurizer consists of a large rectangular shaped tank filled with hot water. The bottles are slowly carried through this in suspended conveyors. The water is heated by steam. Automatic control of this water temperature by means of a valve in the steam line regulated by a thermostat is usual. Both indicating and recording thermometers are used on these pasteurizers with the bulbs installed through the side walls. In addition to the above a special thermometer known as a traveling recorder is used. This is built into a waterproof case and the sensitive bulb is inserted in a bottle and the recorder is kept continuously circulating through the pasteurizer. At the end of the day the chart is removed and examined for any fluctuations in the water temperature. As the bottles come out of the far end of the pasteurizer they are sent to the labeling machine, after which they are ready for distribution.

In outlining the essential steps of brewing, reference has been made to instruments which are now used or might be used. In addition to those already mentioned many more may be included such as liquid level gages on the hot and cold water supply tanks and recording thermometers and temperature regulators on the same tanks, as well as liquid meters to measure not only the beer at various stages but water in processing. Every brewery has a power plant which can use the many instruments that an efficient power station requires. Then a very large refrigerating plant is required and this contains possibilities for the use of many pressure gages, thermometers and automatic control of the refrigerating

(Continued on Page A3)

Control of Fractional-Horsepower Motors

By F. L. SPANGLER*

(Concluded)

Thermal Type of Overload Relay

Fig. 30 illustrates a resistance type of thermal relay, one view showing the relay set and the contacts closed, and the other view the relay tripped and the contacts open. This is a very simple and inexpensive type of overload relay. The relay contacts are maintained in the closed position by a small pawl held firmly against the contact spring by a ratchet wheel, which is soldered to a stationary vertical shaft extending down into the heating element below. When the element carries an overload current, it becomes hot and heats the vertical shaft. When the shaft becomes sufficiently heated, the solder melts, releasing the ratchet wheel and the pawl. Movement of the pawl removes the pressure from the contact spring, which flies back and opens the relay contacts. When the relay trips, the magnetic switch opens and stops the motor. Therefore, no current flows through the heater element, and in a moment the solder has cooled and set, so that the ratchet wheel cannot turn. The relay can now be reset by moving the reset lever to the right with the finger, which causes the pawl to press on the contact spring and close the contacts, and the immovable ratchet wheel holds the pawl in place until the next overload trips the relay. The value of tripping current for which the relay is set can be altered by changing the thermal element. Heating elements covering a wide range of ratings are available.

The overload breaker which was shown in Fig. 1 operates on the ratchet principle used in the thermal relay just described. This breaker is connected into the leads of small d.c. and a.c. motors to give overload protection where magnetic switches are not employed and control is by means of snap switches or other manually operated devices that handle the motor current directly. Fig. 31 shows one of these breakers installed on an oil burner, and in Fig. 32 the breaker assembly is shown without the enclosure. The motor current passes through the heater element, shown near the bottom, across the switch contacts at the upper left, then through the blow-out coil at the rear of the contacts. Beside having a blow-out coil which creates a magnetic field to rupture the arc, these contacts are also equipped with arc shields. This breaker, although rated at 15 amp., is so compact that the enclosing sheet-metal box is only 2½ in. wide and 4⅜ in. high. After tripping, the breaker is reset by means of the knob on the front of the enclosure. A turn of this knob to the right closes the contacts, and the breaker again is ready for operation at the next overload.

Overload Breaker Design

The development of compact, reliable overload breakers has come about as a result of the tremendous increase in the use

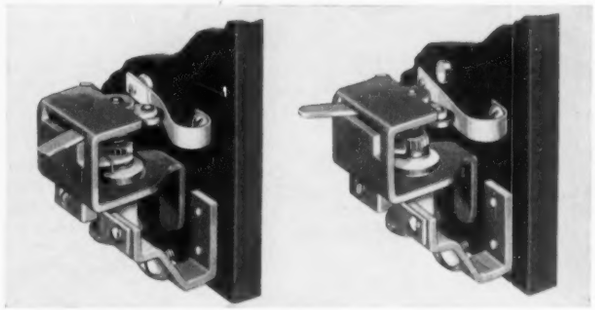


Fig. 30. Thermal type of overload relay. At the left the relay is set for operation and the pawl holds the contacts closed. At the right the relay has tripped and the contacts are opened.

use of small electric motors for numerous devices designed for home and industrial use, and the realization that fuses, being easy to tamper with, do not offer reliable protection. These overload breakers are extremely compact. Their reliability gives a greater factor of safety to motor-driven machines than is obtainable with fuses. Since the tripping value of these breakers cannot be altered except by changing heater elements, and since they can be reset in a moment after tripping without the need of replacements of any kind, there is no temptation to tamper with them.

The average time-current characteristic of this overload breaker is shown in the curve in Fig. 33. With a 300% overload, the time of tripping is about one-third that when the overload is only 200%; and with a stalled rotor, resulting in an overload of about 600%, the time of tripping is further reduced by one-half. Ample time is allowed to bring the motor up to speed from standstill without the tripping of the breaker, but if the overload is sustained to the danger point, the breaker trips and opens the motor circuit. For 3-phase circuits, 2 breakers are used, one being located in each of two leads, thereby giving protection on all 3 phases. The thermal elements used in these breakers are rated at their ultimate current tripping values. For instance if the full-load motor current is 5 amp., a 5.5-amp. element is used if 110% protection is desired.

Other types of protective relays are sometimes necessary to meet the requirements of certain installations. Fig. 34 shows a control panel especially designed for application to motor-driven oil burners, and containing a temperature timing relay as well as overload relays. The circuit diagram of this starter for a 3-phase motor is shown in Fig. 35. The magnetic switch

*Industrial Engineer, Allen-Bradley Co.

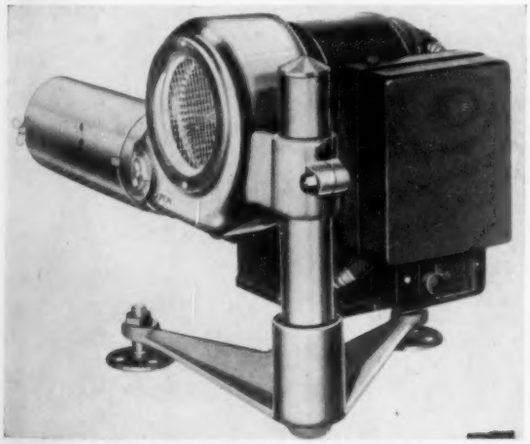


Fig. 31. The motor driving this oil burner is protected against overloads by means of a small overload breaker of 15-amp. capacity mounted at the base of the motor enclosure. To reset this breaker for tripping, it is necessary only to give the reset knob a short turn to the right.

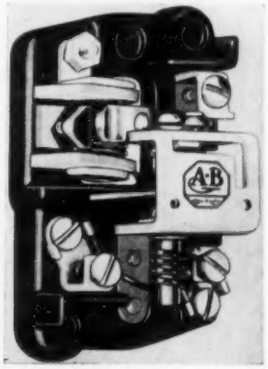


Fig. 32. View of the contacts and heating element of the overload breaker shown in Fig. 31. A blowout coil and arc shields extinguish the arc almost instantly when the breaker opens.

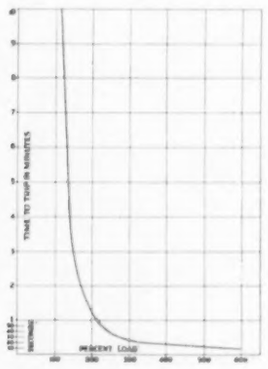


Fig. 33. Curve showing the average tripping time characteristic of the overload breaker shown in Figs. 31 and 32. The greater the overload, the shorter the time required for the breaker to trip.

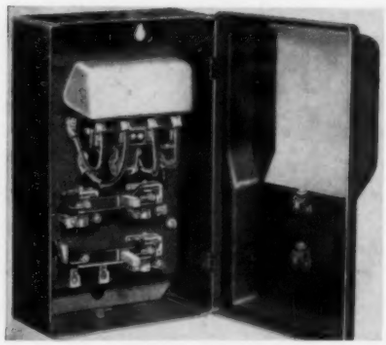


Fig. 34. Control panel consisting of a magnetic switch, temperature relay, and two overload relays, especially designed for use with motor-driven oil burners.

closes and starts the motor when the thermostat makes contact, provided all safety controls such as pressure switches, low water gages, etc., are closed. If the oil burner fails to ignite, the stack safety switch will not operate to by-pass the temperature timing relay. The temperature timing relay then trips, opens the magnetic starting switch, and stops the motor. On the other hand, if the oil burner ignites properly, the stack safety switch closes and by-passes the temperature relay. The magnetic switch, therefore, remains closed until it is opened by the thermostat. The temperature timing relay must be reset manually after it trips.

Pilot Control

The push-button type of control station offers a convenient means for remote control of motors when used in connection with full-magnetic starters or starting switches.

Whenever a carriage or other moving object overruns its limit, the motor driving the object can be stopped—and reversed if necessary—by means of a limit switch which is tripped by the moving carriage. Limit switches are available for operation from a track or by rod, chain, or rope, or operation may be by weights or springs. Where the drift of the machine is small, switches of the snap-over type should be used, since these require a very small travel to cause them to operate. Some of these snap-over switches can be actuated by a travel as little as $\frac{1}{8}$ in.

Where very quick stopping of the motor is desired, without dependence on friction brakes, the plugging type of limit switch may be used. This switch stops the motor by reconnecting it for reversing and then opening the motor leads before the motor has time to reverse its direction of rotation. Where the inertia of the load is not great, this switch will stop a motor and its load in 1 or 2 seconds.

With many pump installations provided with a magnetic switch controlled by a float switch, a try-out switch is provided, by means of which the magnetic switch may be operated independently of the float switch. Try-out switches are also sometimes used with motor-driven refrigeration machines and other devices controlled by 2-wire pilot controls. The try-out switch enables the equipment to be tested following its installation or to be operated in emergencies without dependence on the control device.

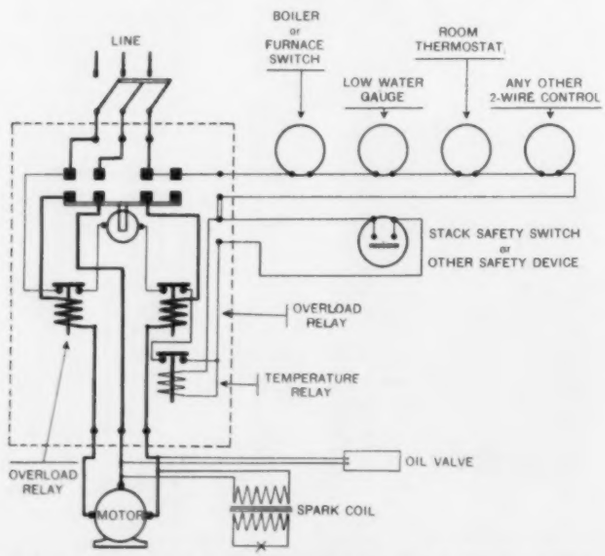


Fig. 35. 3-phase circuit diagram showing method of installing the control panel shown in Fig. 34 when used with the usual standard safety shunting controls.

Fig. 36 shows a connection diagram for a magnetic switch controlled by a 3-way control switch which in its third position functions as a try-out switch. When this switch is in the "Automatic" or first position, the magnetic switch is opened and closed by means of the action of the thermostat. With the control switch in the second or "Off" position, the switch remains open irrespective of the action of the thermostat. In the third or "Hand" position, the control switch keeps the magnetic switch closed and the motor operates so long as the switch is in this position, but the high-pressure gage remains in the control circuit and disconnects the motor from the line by opening the magnetic switch should the pressure become unduly high.

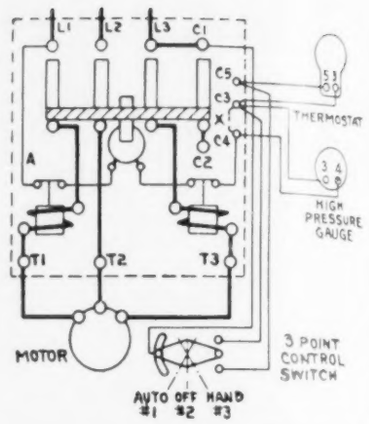


Fig. 36. Diagram of connections of magnetic starting switch installed with a try-out switch for by-passing the thermostat control.

The float switch, Fig. 3, and the pressure switch, Fig. 4, although sometimes used for the direct control of fractional-horsepower motors, can also serve as pilot control devices in connection with magnetic switches or automatic resistance-type starters.

Control by Light-Sensitive Cells

For small motors operating electric light signs, revolving beacons, and in other installations where the control must be turned on and off in accordance with the daylight hours, the photoelectric relay offers a reliable means of control. This relay is also being applied successfully to many other uses than those mentioned. It consists of a light source, shown in Fig. 37, from which a beam of light is focused into a photo-tube. Any great change in intensity of this light beam upsets the electric balance in the photo-tube circuit, causing a small current to flow. This current is amplified to sufficient strength by other tubes to cause it to close or open a set of relay contacts, which may be used to start and stop small motors by the direct making and breaking of the motor circuit, or for controlling larger motors through an automatic starter, the pilot circuit of which in turn is controlled by the opening and closing of the relay contacts. The photoelectric relay shown in Fig. 38 has a capacity of 10 amp. at 110 volts, a.c., non-inductive load. The amplifier tubes, transformer, and relay are enclosed in a sheet-metal cabinet, and the photo-tube is attached to the end of a cable for mounting in any position desired. For outdoor service, the photoelectric relay and light source are provided with watertight enclosures.

Photoelectric relays are used in connection with small motors for opening garage doors, sounding alarms, operating knives for cutting wrappers, and for many other purposes. Complete interruption of the light beam by an automobile causes garage doors to open or close or a traffic signal to operate. The light from a blaze may be detected before the sprinklers can operate, and immediately the relay closes the fire doors and sounds an alarm.

Fig. 37. Light source for photoelectric relay control.

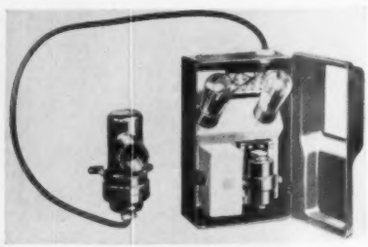


Fig. 38. Photoelectric relay with door open showing amplifying tubes, transformer, and relay. The photo-tube or "electric eye" which receives the light for operation of this relay, is attached to the end of a cable connecting with the amplifier and relay.

Flow Measurement and Control**

By M. F. BEHAR†

CHAPTER XXIII—POSITIVE METERS
(*Continued*)

POSITIVE GAS METERS

10. Bellows

(b) Classifications *(Concluded)*

Other Classifications

From the engineering viewpoint the most significant classification of bellows meters is according to the number of diaphragms and the number of measuring chambers:

(1) A majority of the models available in this country (and the great majority of the meters in service) are of the two-diaphragm four-chamber type, with a partition dividing the meter into two "double-acting slide-valve engines." See Figs. 23-75 and 23-80 to 23-85. This is the "Glover type." All tin case meters and most commercial models of iron case meters belong to this type.

(2) Placed on the market in 1910, Sprague's two-diaphragm three-chamber type has only one stuffing box. Fig. 23-88 shows the No. 1A which is further distinguished by having a rotary distributing valve. Sprague No. 5 meters, however, although of the same two-diaphragm three-chamber type, have a Glover "D" cover on each of their three slide valves.

(3) The third type, now vanishing but still represented by enough meters in service to deserve mention, is the Tobey, an iron case meter with three diaphragms and four chambers. Its vertical shaft, on the center-line of the meter, actuates a rotary distributing valve at the bottom of the central chamber and drives the register at the top, so that there is only one stuffing-box in the meter.

(4) A fourth type would comprise various bellows meters with more than three diaphragms, but none of these appears to be of industrial interest.

Other engineering classifications of bellows meters, of interest because they are based on features that affect performance, are the following:

A. By bellows action, into (1) "folding diaphragm," (2) "rolling diaphragm" and (3) "bending diaphragm." Although there is a scientific basis for this classification, exact definitions have not been adopted and it seems to the author that the whole matter has degenerated into a logomachy, each expert insisting that the diaphragm leathers in the particular meter that he favors are the ones that flex with most evenly distributed stresses.

B. By "positiveness" of displacement. Equally interesting in principle. The new German idea is to provide stops for exactly and adjustably limiting the travel of the diaphragm disks. Wonderful in theory, but high-grade American meters depending on adjustable tangents are just as positive in practice.

C. By type of valve. The recent appearance in this country of poppet-valve meters aiming at sharpness of admission and cut-off points has started technical discussions along this line.* Three types of valves are now in use: (1) Conventional "D" slide valves, (2) rotating-cover distributing valves and (3) poppet valves.

COMMERCIALLY AVAILABLE METERS

(e) Tin Case Meters

All of these are low pressure meters, rated at 2″ inlet pressure with a working pressure limit of around 14″ (or around 0.4 lb gage). Even at this pressure, most of them—especially the larger industrial sizes—begin to show elastic deformations measurable with dial gages, and at around 30″ of water the bulging is noticeable and some of the affected parts may take a permanent set, altering the proof. Hence the importance of protecting them by dependable pressure or vacuum regulators. See Fig. 23-74.

*But all in confidence. None of the meter company and utility engineers who have expressed their views to the author has released such expressions for publication. The author cannot cite other references than articles in recent and current volumes of *Das Gas- und Wasserfach, Zs. V.D.I., A.T.M.*, etc.

**Part Six of *The Manual of Instrumentation.*

†Editor, *Instruments.*

BAILEY METERS

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Metering, Controlling and Regulating Equipment

—METERS—

BOILER METERS for recording combustion conditions and guiding boiler operators.

RATIO METERS for measuring fuel and air to furnaces to guide combustion.

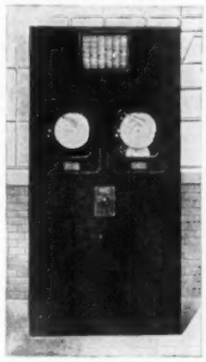
FLOW METERS for indicating, recording and integrating the flow of steam, water, sewage, air, gas and other fluids.

Fluid Meter

RECORDERS for temperature, pressure, draft, speed and other factors.

—CONTROLS—

COMBUSTION control to maintain steam pressure and combustion economy.



Control Panel

SYSTEMS to regulate pump speed, reheat temperature, desuperheat and other factors.

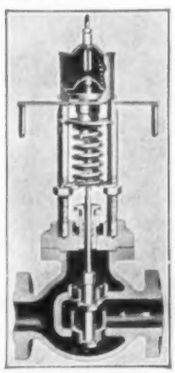
CONTROLLERS for rate of flow, pressure, temperature and other factors.

—REGULATORS—

FEED WATER regulators for feed water to steam boilers.

PRESSURE regulators for heating and process services.

DRAFT regulators to maintain the desired draft in furnaces, kilns and small steam boilers.



Regulating Valve

Complete information on any of the above Bailey products will be gladly furnished upon request.

G-1

BAILEY METER CO.
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MANUFACTURERS' LITERATURE

In this department we each month list the printed matter issued by manufacturers. Unless otherwise noted, any of the items listed may be secured free upon application to the issuing firm. Manufacturers who have not yet sent in their printed matter are invited to do so.

A178 **Industrial Instruments.** Binder of new bulletins as follows: T24 "Mersteel" temperature recorder; G15 "Barnsbury" pressure recorder; T22 multipoint recording pyrometer; TR7 pyrometer controller; D16 edgewise case indicating thermometers for Diesel engines, etc.; DH1 "Hygrovisor" and "Dewvisor" humidity indicators; G10 transmitting oil pressure gages; T16 transmitting thermometer for aircraft; G140 absolute pressure gage of dial type for superchargers; TG2 liquid level gage; OT1 oven thermometer; M2242 photographic temperature recorder. Negretti & Zambra, London, England.

A179 **Micro Switch.** Folder on snap switch requiring 0.004 in.-oz. energy for operation. C. F. Burgess Laboratories, New York.

A180 **Hydraulic Tables** and other data collected from many sources are assembled in 32-page Bulletin 25. Baldwin-Southwark Corp., Philadelphia.

A181 **Electrical Instruments.** 20-page Catalog No. 48 covers switchboard and panel instruments of round, rectangular, horizontal edgewise and illuminated-dial models, brackets, multipliers, shunts and other accessories. Roller-Smith Co., New York.

A182 **Timing Device for Testing Watthour Meters.** 4-page descriptive bulletin. The Standard Electric Time Co., Springfield, Mass.

A183 **Small Transformers.** Leaflet 20576 on Type MT small transformers for furnace control, etc. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

A184 **Battery Chargers.** Leaflet 20570 on Rectox full-wave copper-oxide rectification chargers. Also Leaflet 20571 on Rectox copper-oxide rectifying elements of various designs and ratings. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

A185 **Lighting Control.** Leaflet 20579 on Photolux automatic control of artificial light. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

A186 **Motor Control.** Leaflet 20499 on combination linestarters for squirrel cage and wound rotor induction motors. Leaflet 20581 on starting and speed regulating rheostats for d.c. motors. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

A187 **Thermoguard Motors.** 12-page descriptive announcement of overload-protected motors. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

A188 **Oscillography.** D & T No. 34 on new improvements in Type PA automatic oscillograph; D & T No. 35 on instructions for operating cathode-ray oscilloscope. Westinghouse Elec. & Mfg. Co., Newark, N. J.

A189 **Rheostats.** Bulletin 1105 describes a new ring type 100-watt rheostat with "dead" shaft construction. Ward Leonard Electric Co., Mt. Vernon, N. Y.

A190 **Motorized Valves.** Loose leaf bulletin describes Type 2 devices for 1 or 2 valves. Automatic Temperature Control Co., Philadelphia, Pa.

A190 **Control Motors.** 4-page bulletin describes valve-operating power units. Minneapolis Honeywell Regulator Co., Minneapolis, Minn.

A191 **Solenoid Operated Valves** in 2-, 3- and 4-way types are described in Bulletin 1032. W. H. Nicholson & Co., Wilkes-Barre, Pa.

A192 **Galvanizing Bath Control.** Reprint from "Steel" describes temperature control system. Leeds & Northrup Co., Philadelphia, Pa.

A193 **Water Works Tools** is the title of a catalog which includes also specialized instruments. H. W. Clark Co., Mattoon, Ill.

A194 **Fine Wires.** 12-page booklet lists also metallic ribbons and foils. Baker & Co., Inc., Newark, N. J.

(Continued on Page 160)

Note that the cases of "tin" meters are actually made of highest grade tinned steel sheets.

The characteristics of these meters were outlined in Art. **(a)** and briefly compared in Art. **(b)**; their ratings were given in Art. **(c)**. The present article is purely descriptive of commercially available tin case regular-service meters, discussion of special models being left for Art. **(h)**.

Tin case meters having originally been designed for house metering and this being their principal application today, not only has their design been standardized but even engineering specifications laid down by all large governmental and corporate purchasers echo one another in nearly every respect. The several makes have many parts interchangeable and look so much alike inside that cutaway views can only be identified by a few gas engineers and dismounted meters by none but experienced shop men. The various manufacturers can only vie with one another in the way of materials, construction, workmanship, etc. Important as are some "exclusive features" to engineers using meters for strictly industrial purposes, they need not be discussed critically here, for the makers' highly-detailed booklets are readily available. It may be mentioned, however, that tin case meters of recent and current manufacture can stand 50% overload for brief periods without appreciable injury and without alteration of proof. This is true of those made by meter works whose engineers study the requirements of industrial plants.*

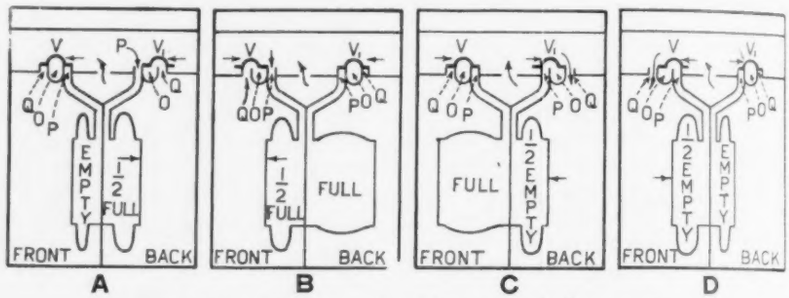

Fig. 23-75. Operation of a Glover type bellows meter.

These diagrams show the relative positions of valves and diaphragms at the four points of cut-off viewed from outlet side. The tangent arm and crank revolve clockwise. (From the Am. Gas Ass'n handbook by G. A. Lane and W. A. Castor.)

The motive power that actuates the meter is the difference in pressure of the gas at the meter inlet and outlet. No motion can take place unless this differential exists. As the valves are at right angles to each other and connected to a single crank, there can be no position when both valves are on dead center. Assume that the gas is turned on when the valves and diaphragms are in the relative positions shown in Fig. A. The back chamber is connected through the port (Q) of the back valve (V_1) to the meter outlet (O). The back diaphragm is also open to the pressure of the inlet gas. The gas entering the back diaphragm pushes it out, forcing the gas in the back chamber through port (Q) of the back valve (V_1), to the meter outlet (O). The front valve (V) is on dead center, or at its point of cut off sealing both the diaphragm and the diaphragm compartment.

Relative positions are next shown when back valve (V_1) has reached its dead center position (Fig. B), shutting off back diaphragm from the inlet gas and back diaphragm compartment from the outlet. But while this has been occurring, front valve (V) has moved to allow inlet gas to enter the front diaphragm, forcing the gas in the front diaphragm compartment through front valve port (Q) to meter outlet (O). Thus when the back valve is in a position that prevents the back diaphragm or back diaphragm compartment from supplying gas to the meter outlet, the front diaphragm is moving outward, forcing the gas out of the front diaphragm compartment.

In Fig. C, the front diaphragm has filled and front valve (V) has moved back to dead center. Back valve (V_1) has reached the end of its inward stroke and the inlet gas is now entering the back diaphragm compartment, pushing the gas from the back diaphragm through port (P) of the back valve to the meter outlet through (O).

Fig. D shows the fourth position in the cycle. The inlet gas has pushed the back diaphragm to its "empty" position at which point back valve (V_1) shuts off inlet gas, preventing further motion. Front valve (V) meanwhile has moved "in" to the end of its stroke and the gas now enters the front diaphragm compartment, forcing the gas out of the front diaphragm.

The next step in the cycle would bring us back to the valve and diaphragm relations shown in Fig. A following each other in the order described above as long as the meter outlet pressure is below the inlet pressure.

The positions of valves and diaphragms shown above are called the points of cut off, when the tangent arm is rotated in a clockwise direction. At all other positions of the valves both diaphragms and both diaphragm compartments are either receiving or delivering gas.

Although all tin case meters now manufactured in the U. S. are of 0.5" rating and of the Glover slide-valve, two-diaphragm, four-compartment design, their development since around 1904 has proceeded along three slightly different lines in response to more and more exacting requirements, until now there are three slightly different sub-types, all standardized, designated as "B", "A" and "C" (this being the chronological order of their recognition). Some of the differences will be pointed out in the following description.

Fig. 23-75 shows the operation of any Glover type meter—tin or iron. Note that the simplified diagram shows "channels" from the inner measuring chambers ("diaphragm compartments") to the valve seats. These are the "diaphragm

*It may not be true of meters made by other companies. The extent to which the makers support research projects and are represented in technical associations is a pretty fair criterion of the relative suitability of their products for engineering measurements.

channels" (formerly called "pockets"). The lower horizontal partition, carrying the valves, is generally called the "table" (its official name is "valve table"). The space between the table and the upper partition in the diagram represents the "valve box," which in actual meters is a small gas-tight compartment enclosing the valves. In all Glover meters—both tin and iron—the whole space above the valve table is called the "gallery." In tin case meters (other than special "test meters" with hand-holes) it is only accessible by removing the soldered top plate—a point well worth bearing in mind where the physical properties of the metered gas vary. Ordinarily, though, this tamper-proof construction is unobjectionable.

With the top removed from a tin case meter, the distinctive designs of the B, A and C types can be seen. First, note in Fig. 23-75 that three other channels are shown in cross-section: two are marked **O** and one is the V-shaped space between the valves and under the table. The two channels marked are the two branches of one Y-shaped outlet channel; the central one is the inlet or "long" channel. Next examine Fig. 23-80 (American Meter Co.'s 5-B-150 meter). This is a typical B meter. Note how it corresponds to Fig. 23-75

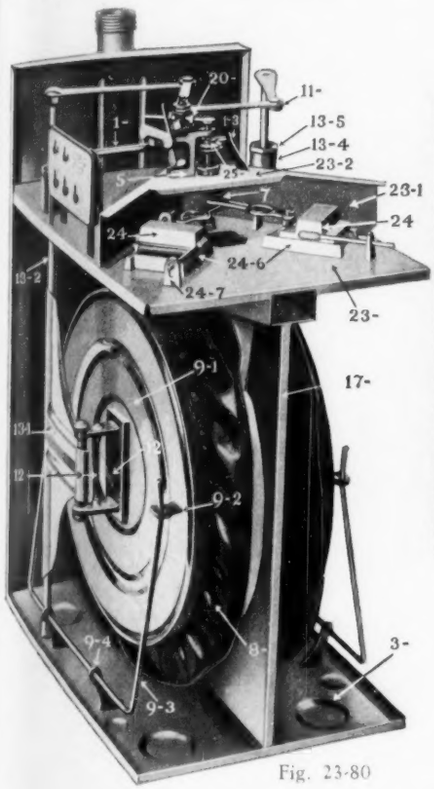

Fig. 23-80

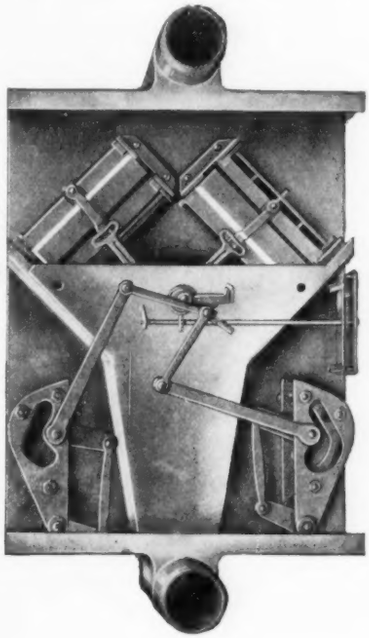

Fig. 23-81

in a general way, though the valves are set at 90° to each other. Next, examine Fig. 23-81, the American Meter Co.'s C type viewed from above, and note how the valve box enclosure includes the inlet channel. In *both* the A and C types, the valve box and inlet channel are one-piece and located above the valve table, whereas in the B meter the inlet channel is soldered to the under side of the table.

The principal differences, however, are that the new C meter has much wider valves and channels than B and A meters of corresponding outside dimensions, and that it also has double-extension (true "bellows") diaphragms, so that size for size and weight for weight, its capacity is approximately 150% that of the A meter—which, by the way, has a slightly greater capacity than the B. Examples (all American Meter Co.'s meters):

Meter	30-B		6-C		20-B	25-C		60-A
Capacity, cu. ft. per hour	600	=	600	>	450	2500	>	1500
Weight, lb.	46	>	33	=	33	122	<	128
Height, in.	26⅛	>	19¾	<	22	34	≃	33⅛

Tin case meters find many applications in industry. Most engineers simply take them for granted, knowing that they can run 10 years without attention, and give little thought to their maintenance until repairs are necessary. "Then the fun begins"—for, in order to get at the mechanism, it is necessary to scrape the paint off the solder seams, apply an oil flux, run the solder off, and

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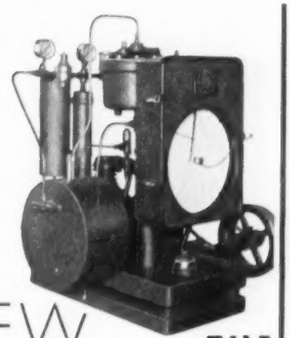

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METRIC METAL WORKS *ERIE, PENNSYLVANIA*

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A195 **Flue Gas Analyzers.** 24-page Catalog TSE 33 describes Orsat outfits and portable combustion test sets. Bulletin 2006 is a 16-page booklet "Handling the Orsat" written in sprightly non-technical style. The Hays Corp., Michigan City, Ind.

A196 **Industrial Instruments.** 28-page Pocket Catalog No. 13 is a profusely-illustrated catalog of the complete line of the Defender Automatic Regulator Co., St. Louis, Mo.

A197 **Chronometer Valves.** 4-page Bulletin E describes new Improved Fitts Type adjustable regrinding manual or automatic control valves. Defender Automatic Regulator Co., St. Louis, Mo.

A198 **Smoke Indicators.** A pocket folder on cross-flue optical devices and various instruments. Ess Instrument Co., Parkersburg, W. Va.

A199 **Microscopes.** 6-page Bulletin No. 8 on a new chemical microscope; also 16-page Bulletin No. 9 on wide-field binocular microscope with many new accessories. E. Leitz, Inc., New York City.

A200 **Geophysical Surveying.** 8-page Form 533 on the portable "Metalloscope" of Dr. Gerhard Fisher. Metalloscope Sales Co., Los Angeles, Calif.

A201 **Resistors.** Bulletins 11, 19 and 25 are now bound as a 20-page booklet; "Ohmite News" for June-July contains a technical article on increasing milliammeter range; Catalog No. 9 describes rheostats and resistance units. Ohmite Mfg. Co., Chicago, Ill.

A202 **Frequency Equipment.** 4-page Bulletin 17 describes a new frequency monitor and a new frequency meter; 4-page Bulletin 26 describes a new frequency converter. Int. Broadcasting Equip't Co., Chicago, Ill.

A203 **Universal Optical Bench.** A novel combination is described in an 8-page bulletin thus titled. R. Fuess, Inc., New York City.

A204 **Time Switch.** Bulletin and card describe new time switch which runs after current fails. Walser Automatic Timer Co., New York City.

A205 **Ground Testing.** 4-page Bulletin 1360 describes latest "Megger" line. James G. Biddle Co., Philadelphia.

A206 **Colorimeters.** 12-page List 200-S describes Hellige-Dubosq large and junior models, horizontal and micro colorimeters. Hellige, Inc., New York City.

A207 **Fluid Meters.** 16-page Catalog EG-2 describes Westcott orifice meters; 16-page Bulletin E-16 describes integrating orifice meters and flowmeters. American Meter Co.'s Metric Metal Works, Erie, Pa.

A208 **Pressure Control.** 40-page Catalog RG-1 describes "Reliance" line of gas regulators. American Meter Co., New York.

A209 **Gravitometer.** 16-page Bulletin E-21 describes new continuous-recording instrument for gas. American Meter Co.'s Metric Metal Works, Erie, Pa.

A210 **Densitometer.** Folder on "Pycnograph" continuous-recording instrument for liquids. The Hays Corp., Michigan City, Ind.

A211 **Furnace Atmosphere Tester.** 6-page bulletin on Model RZA combustible gas analyzer. Bacharach Industrial Instrument Co., Pittsburgh, Pa.

A212 **Furnace Atmosphere Control.** An 18-page bulletin assembles data on Askania systems for furnace atmosphere and temperature control. H. A. Brassert & Co., Chicago, Ill.

A213 **Scopometry.** Folder on Exton Junior instrument for colorimetric and turbidimetric measurements. Bausch & Lomb Optical Co., Rochester, N. Y.

A214 **Noise Meter.** An 8-page mimeographed bulletin discusses a portable noise meter. E. E. Free Laboratories, New York City.

A215 **Psychrometric Chart.** H. W. Carrier's useful chart, reproduced 14" wide in 2 colors, with explanations. Carrier Eng. Corp., Newark, N. J.

A216 **Lovibond Comparator.** 4-page bulletin on a new form of comparator for colorimetric determination of pH of solutions. The Tintometer, Ltd., Milford, Salisbury, England.

A217 **Electrical Instruments.** 36-page condensed catalog gives specifications of all Cambridge instruments. Cambridge Instrument Co., New York City.

A218 **Radiation Pyrometers.** 16-page catalog on latest models. Cambridge Instrument Co., New York City.

carefully follow a complicated routine which has almost become a ritual. It is much preferable to send tin case meters for repairs to the manufacturer, or to gas companies' shops.

(f) Pressed Steel Meters

Developed since the world war, especially for industrial service, these meters are only made in fairly large sizes but are "accurate from pilot light volumes" (at 10" water inlet pressure—not 2" which is the tin meter basis) up to capacity flows at maximum allowable pressures which are 50 or 75 lb. They are ruggedly built, are bolted throughout (no solder), and ordinary mechanical repairs can be made by industrial plant maintenance men. They are lighter and much less bulky than even the C type of tin case meters of corresponding ratings but *not* under *similar* working conditions.

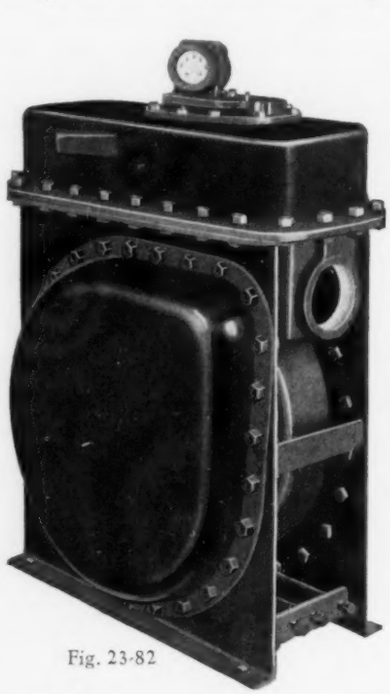

Fig. 23-82

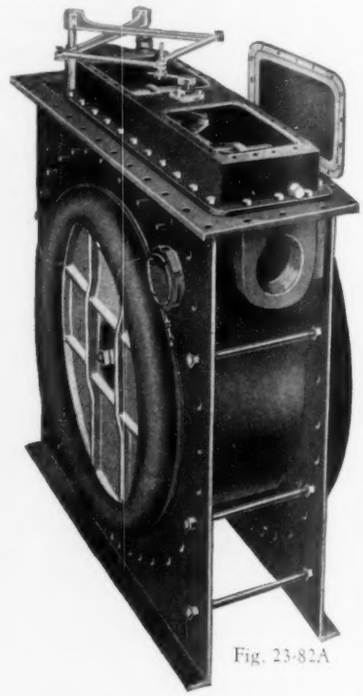

Fig. 23-82A

To illustrate: the 17,500 cu. ft. No. 170C tin meter weighs 1430 lb whereas the No. 5 pressed steel meter which has a maximum capacity of 30,000 cu. ft. weighs 980 lb. but this 30,000 cu. ft. is the register reading reduced to 4 oz. base pressure when measuring gas at 50 lb pressure. Now, if we rate the pressed steel meter on the same basis as the 17,500 cu. ft. tin meter, i.e., with a U-gage connected to inlet and outlet and the drop carefully maintained at exactly 0.5, we find that it passes not 30,000 but 4000 cu. ft. per hour of 0.60 gas.

In other words, pressed steel meters, though frequently selected for low pressure work, have a special field of their own which may be called the industrial large-volume medium-pressure field. To quote a firm of consulting engineers:

". . . unable to buy the more expensive types of large volume meters, and they cannot obtain accuracy from the cheaper types. A — — is so simple that it can be read by anyone and if repairs are necessary they can be made by any mechanic."

The operating principle is similar to that of the tin case meters, and the same nomenclature is used, although the arrangement and proportions are different.

Fig. 23-82 shows the Emco Large Capacity meter (Pittsburgh Equitable Meter Co.). Narrow width is the most noticeable feature (the makers assert that "several can be placed side by side in the floor space formerly required by one meter of smaller capacity") and is achieved by valves set in line instead of at 90°. Fig. 23-82A brings out the "closed top" whereby the tangent, flag arms and tangent links are not exposed to gas, so that the meter can be adjusted by merely removing the oval register plate on top of the outer cover.

(g) Iron Case Meters

Ability to withstand high pressures (up to 500 lb in some models) is the distinctive characteristic of the meters we now come to, and defines their principal industrial field. Originally, though, cast iron meters were introduced chiefly to meet the natural gas industry's demand for outdoor meters. Only standardized industrial designs will be taken up, precision and other special models being dealt with in Art. **(h)**. Even within these topical limits there are to be found many different meters (because iron case meters are made not

only in the Glover type but in other types mentioned under "Classification"). Adequate descriptions would require some ten pages; the following descriptions, restricted to type examples of three makes, may not do justice to this important field.

Note that some "iron" meters for low and medium pressures are actually made of pressed steel or have pressed steel front and back plates.

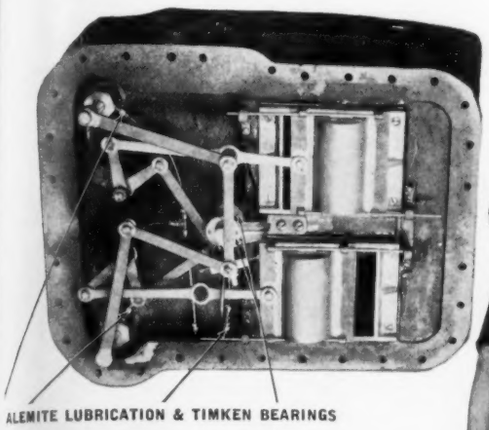

Fig. 23-83

Fig. 23-84

Fig. 23-85

American Meter Co.'s "Ironcase" series.—Fig. 23-84 is a cut-away view of the smallest size, the 5-B which has a maximum hourly capacity of 370 cu. ft. at 2" drop. Note the slide valves set at 90° and other resemblances to tin case meters. The principal difference is that the body (including table, vertical partition, outlet channel and both diaphragm channels) is cast in one piece. The other parts of the case are the front, the back, the top, the index box and the hand-hole disk (for a tapped hand-hole located at the center of the top to permit observing and adjusting the action of the valves and the setting of the tangent). Medium sizes, up to the 60-B (capacity 18,000 cu. ft.—expressed at 4 oz. base—at 250 lb) are similar in design but the barrel is larger in proportion to the valve box. Large sizes (and two medium sizes, namely the 25-B and 35-B) have the valves set parallel and side by side. See Fig. 23-83. This recent, ingenious, valve mechanism requires a greater number of bearing points than the conventional action, but the angular motion of working parts is less —so that wear is actually reduced—and the valves are always in time with the diaphragms. All Ironcase meters with this new valve action have Alemite lubrication from the outside to stuffing boxes and bearings. The largest standard Ironcase can pass 90,000 cu. ft. (expressed at 4 oz. base pressure) at 250 lb gage pressure; weighs less than half a ton and measures 41" high by 30½" wide and 30½" deep.

Pittsburgh Equitable Meter Co.'s "Emco Large Capacity" Iron Meters—Each of the three sizes of these meters is made in four outer casings, for 75, 100, 200 and 500 lb pressures. The two larger sizes are made in both a "crank type" and a "gear type" of valve mechanism, the former being of more or less conventional design and the latter with parallel side-by-side valves driven by a recently developed action (which, however, cannot be selected where the gas to be metered is dirty or is likely to corrode the precisely-

A219 **Recording Counters & Chronographs.** 8-page catalog describes latest models. Cambridge Instrument Co., New York City.

A220 **Bakelite Information.** June 1933 issue features heat resistant material. Bakelite Corp., New York City.

A221 **Photoelectric Cell.** 4-page folder on "J6" Cico Cell. Clark Instrument Co., Inc., Camden, N. J.

A222 **Lubricant.** Bulletin N200 on colloidal graphite. Acheson Oildag Co., Port Huron, Mich.

A223 **Instrument and Apparatus Supports.** 4-page Bulletin 1 and 8-page (blueprints) Bulletin 2 describe rigid non-magnetic adaptable supports. Bryden Co., Waltham, Mass.

A224 **Midget Relays.** Bulletin 106 listing 130 Midget Magnetic Relays with circuit diagrams and contact arrangements. Ward Leonard Electric Co., Mount Vernon, N. Y.

A225 **Vitrohm Rheostats** with fine continuous adjustment. Bulletins 1103 and 1105 and Adjustat Bulletin 1104 on rheostats for fractional h.p. motor control, filament control, etc. Ward Leonard Electric Co., Mount Vernon, N. Y.

A226 **Fractional Horsepower Gear Motors.** 4-page bulletin describes construction and characteristics. General Electric Co., Schenectady, N. Y.

A227 **Photoelectric Relay.** 4-page bulletin GEA-1755 describes relay and uses. General Electric Co., Schenectady, N. Y.

A228 **Motor Starting Switches.** 4-page bulletin GEA-1761 describes characteristics and applications. General Electric Co., Schenectady, N. Y.

A229 **Automatic Control.** Striking broadside entitled "Are you ready for the New Deal?" The Foxboro Co., Foxboro, Mass.

A230 **American Brewery Meters** is the title of a 4-page bulletin on new meters brought out by Buffalo Meter Co., Buffalo, N. Y.

A231 **Switchboard Instruments.** 12-page catalog GEA-1758 describes rectangular instruments with new anti-glare glass, antiparallax arrangement, magnetic damping, high factor of merit and other modern features. General Electric Co., Schenectady, N. Y.

A232 **Sag Meter.** 8-page technical bulletin on new Küppers instrument. American Askania Corp., Houston, Tex. and Chicago, Ill.

A233 **Sea Surface Temperature Recorder.** 4-page bulletin. Negretti & Zambra, London, England.

A234 **Hot Roller Thermometer.** List T28 describes this new instrument with special concave bulb. Negretti & Zambra, London, England.

A235 **Continuous Gas Indicator.** 20-page booklet describes novel industrial instrument employing new principles and discusses its practical applications in oil and chemical industries. Griffin & Tatlock, Ltd., Kingsway, London WC2, England.

A236 **Rheostats.** 2 new folders feature moisture-proof enclosures and high watt ratings. Ward Leonard Elec. Co., Mt. Vernon, N. Y.

A237 **Radio Parts.** 4 new 2-page circulars cover Type 35 laminated sockets, Multi-polar rotary switches, Maximum utility adapter and Universal analyzer adapter. The H. H. Eby Mfg. Co., Inc., Philadelphia, Pa.

A238 **Solenoid-operated Valves.** 4-page Bulletin 633 explains uses of different models and lists characteristics. W. H. Nicholson & Co., Wilkes-Barre, Pa.

INSTRUMENTS, 330 W. 42nd St.
New York City

Please have me supplied with a copy of each piece of Manufacturers' Literature listed below.

.....

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Name.....

Position.....

Firm.....

Street and No.....

City.....State.....

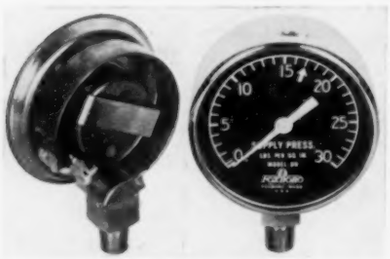
NEW INSTRUMENTS

Write Information Section, Instruments Publishing Company, for additional information.

Two-inch Bourdon Gage

The Foxboro Co.

EXCEPT for its small size, this new "Model DH" dial-indicating pressure gage resembles the industrial instruments of this class and is not to be confused with miniature gages which give a rough indication rather than an accurate measurement. Limit of error is 1% of scale range. Accuracy guarantees are the same as for the makers' larger instruments. Pressure-responsive element is a full-length Bourdon spring, mini-



mizing multiplication (and consequent errors) and making possible a scale extending over 270° of arc. Drawn brass case and ring with buffed nickel finish (buffed brass or chromium finish optional). Top, bottom, left or right side connection. Dials with black background and white block figures, or white background and black figures. Plain, tapered pointer makes the 2" gage easy to read. Ranges from 0-15 lbs./in.^{2} to 0-300 lbs./in.^{2} as well as 0-30" mercury vacuum.

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Motor Speed Control

General Electric Co.

EFFICIENT operation at *variable* speeds of a *synchronous* motor, by means of a new type vacuum tube control, was demonstrated in the G.E. test laboratories at Schenectady to A.I.E.E. delegates last May. The equipment demonstrated consists of a 400-h.p. motor and 18 Thyratron tubes. Power is fed into the bank of tubes directly from a 4,000-volt line. The tubes convert this power into different frequencies before it is delivered to the motor. This varying frequency in the current results in varying speeds of the motor. "The tubes, in changing the frequency of the current, perform the function of a commutator," explained Dr. E. F. W. Alexanderson. "The grid control makes it possible to start with full torque from stand-still and to operate the motor at any desired speed without wasting power in resistance. Much engineering work is still ahead of us. However, I feel that this development points the way to a new era in the electrical industry, in which many important functions and power transformations will be performed by vacuum tubes. The motor demonstrated was 400 h.p., and the efficiency of the frequency converter 98½%."

machined parts). Interchangeability, however, is the most obvious distinctive characteristic of this line. The outer casing consists of three parts—the body, which has a vertical partition, the cover and the index plate—all three of the specified pressure-resistance. The measuring mechanism—diaphragms, flags, tangent, valves, etc., all assembled on the "valve plate"—slips into the body as shown in Fig. 23-85. It usually takes less than half an hour to replace one mechanism with another, for the meter body need not be torn out of the line; and the fact that one man can carry the mechanism of a large Emco meter up or down a flight of stairs solves some of the problems caused by the seemingly incurable habit of setting bellows gas meters down in the most inaccessible places. Each diaphragm leather is attached to a large fixed "outer pan" and to a small movable "inner pan" in such manner that the diaphragm forms a ring of U cross-section and "rolls" as the inner pan moves back and forth, distributing the bending strains over the entire annular area of the leather.

The largest size has an hourly capacity of 53,500 cu. ft. (reduced to 4 oz. basis) of 0.6 gas at 500 lb per sq. in., weighs less than half a ton and measures 34¼" x 29¼" x 21¾" with 500-lb pressure casing.

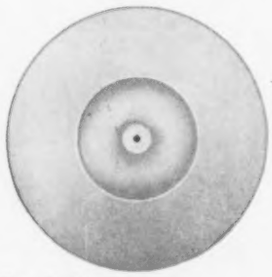
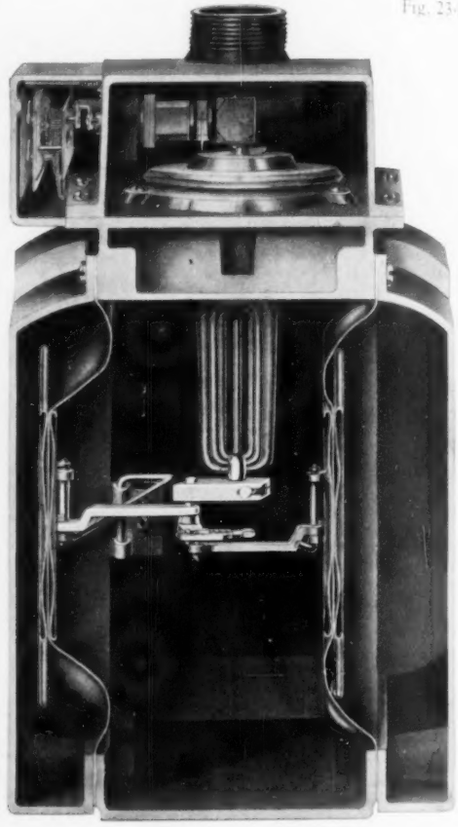


Fig. 23-86

Fig. 23-87

Fig. 23-88



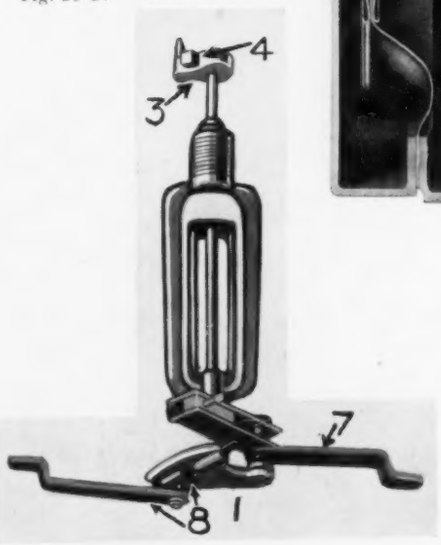


Fig. 23-89

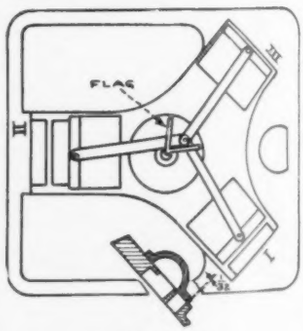


Fig. 23-90

Sprague Meter Co.'s "A" Type.—These meters are of the two-diaphragm three-compartment type with a rotary distributing valve. Figs. 23-86,87,88,89 bring out the distinctive features, but the sectional view does not show that all channels are cast-in—a feature worth mentioning. These channels end up

at the peculiarly-shaped white-metal valve seat, Fig. 23-87. The glass valve cover, Fig. 23-86, does not rotate wheel-like, but executes a rotary oscillating sliding motion over the ports of the seat, being driven by tangent crank (3), Fig. 23-89. The hole at the center of the glass valve fits over the pin of the tangent crank and the pull is exerted in the plane of the sliding contact surfaces, minimizing uneven wear. Fig. 23-88 brings out the shape and method of attachment of the seamless diaphragms, whereby condensation cannot accumulate but drains by gravity. The diaphragms, marked with year of manufacture, are clamped between the flanges of the castings, with oiled paper gaskets preventing leather-to-metal contacts. There is only one stuffing box, where the register drive shaft passes through the top casting. In the newer models, adjustments of crank angle and of "speed" (diaphragm stroke length) can be made from the outside by means of a long socket wrench inserted through a hole in the side of the center casting to turn either of two square-head adjusting screws.

This type of Sprague meter is only made in comparatively small sizes, with hourly capacities of 315, 575 and 654 cu. ft. of 0.6 gas at 5″ inlet pressure and 1.7″ differential. At 50 lb inlet pressure (the highest for which these meters are made), these capacities would be approximately four times greater

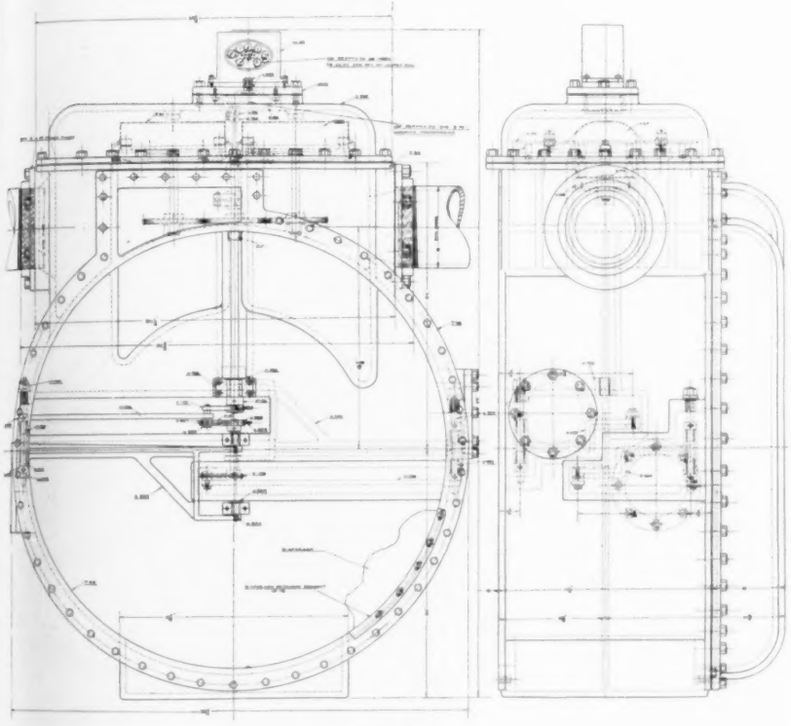


Fig. 23-91

when expressed on the 4 oz. basis, but as explained in Art. **(d)** there are limits to the combination of high differentials and high meter speeds.

Similar outwardly to the foregoing, the *Sprague No. 5* iron meter is likewise of the two-diaphragm three-compartment type, but it employs three slide valves, driven as shown in Fig. 23-90, and it is larger: 1540 cu. ft. of 0.6 gas at 5″ inlet pressure and 1.7″ differential; weight, 170 lb; maximum pressure, 50 lb.

The *Sprague "Dreadnought"* is a modified Glover type, of 373 cu. ft. capacity at 1.7″ differential. The central vertical partition, characteristic of the Glover type, is shaped to accommodate a "main movement" similar to (1) in Fig. 23-89 and likewise adjustable from outside.

The *Sprague No. 20*, Fig. 23-91, is both the newest iron meter (1933) and the largest, having a maximum hourly capacity of 200,000 cu. ft. (4 oz. basis) at maximum pressure which is 75 lb gage. At 4 oz. pressure and 2″ drop, its capacity is 32,000 cu. ft. It is a modified Glover meter with side-by-side "D" valves driven through gears from cranks connected to the centers of the diaphragm disks; and with the central partition shaped to accommodate this crank action which is adjustable from outside. Dimensions, 42″x32″x57″ high.

Brewery Liquid Meter

Buffalo Meter Co.

RECENT progress in design and construction of positive liquid meters has resulted in what is announced as a beer meter "built to standards far surpassing those of the old-time beer meters used before prohibition." The nutating positive displacement member is not made of hard rubber but of a composition uninjured by either alcohol or hot water. Maximum error at normal flow is $< 0.5\%$; at 1/20 of capacity flow, $< 2\%$. Three sizes are available, $2\frac{1}{2}$, 3 and 5 bbls. per minute maximum capacity; each in two pipe or hose connection sizes, and with either "1 & 20" or "10 & 200" bbl. vertical reset dials, 6″ in diameter with totalizing counters.

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Improved Tape-Rule

The Lufkin Rule Co.

EXTREME compactness has been achieved in the newest model of Lufkin tape-rules, the "Aristocrat," a 6-ft. measure which weighs only 2 oz. and has a stainless steel case $1\frac{5}{8}$″ in diameter. In addition to the usual marking in inches and sixteenths, one style is available with engineers' markings.

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Five-inch Dial Thermometer

C. J. Tagliabue Mfg. Co.

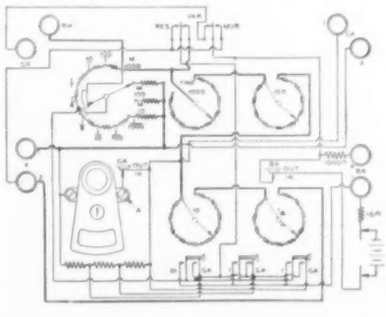
DEVELOPED for equipment manufacturers who demanded a moderately priced but dependable dial-indicating thermometer, this new instrument has been brought out in a black Bakelite case, black dial with white graduations and white pointer—the latter actuated by a bronze bellows through a vibration-proof mechanism. Six ranges are standard, the lowest —40 to +65°F. and the highest 200 to 335°F. Brass or steel bulbs are available in two lengths and with either plain or $\frac{1}{2}$″ pipe thread union connection.

◆ ◆ ◆

"Type U" Testing Set

Leeds & Northrup Co.

SPECIALLY designed for locating faults in communication circuits, Testing Set No. 5430 is a portable Wheatstone bridge which can also be used for measuring conductor resistance, for Murray and Varley loop tests, for capacitance tests in locating opens, for identifying faulty wires in a cable, and for laboratory tests as well because its rheostat limit of error is 0.1%. Galvanometer resistance is 250 ohms; period 3 seconds; sensitivity at least 1 megohm; deflections proportional to 0.01, 0.1 or all of circuit current. Weight, about 8 lbs.



Automatic Weigher-Filler

Toledo Scale Co.

MANUFACTURERS of small metal products, such as nails, clips, and pins can achieve revolutionary results through use of this improved weighing and automatic filling device, it is claimed. This device will easily weigh as high as 1,000 1-lb. packages an hour to an accuracy of $\frac{1}{16}$ ounce. All drafts are net weighings, the weight of the container not being included in any part of the weighing operation. Breaking, cutting, and crushing of the commodity are practically eliminated. All operations are error-proof, because of electrical interlocking against inaccuracies due to mechanical fault. If desired, the predetermined net weight can be easily and quickly checked on a clearly-marked

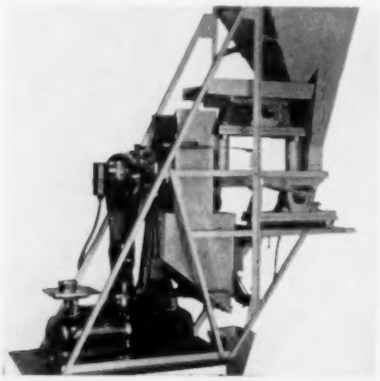


chart at any time during a run, by pressing a button and with but a slight pause in the operation. A vibrator feeder and a pre-weigh hopper on a predetermined-weight scale measures out to within a small percentage of the total load. Material is automatically dumped into the final weigh and dump hopper, where another vibrator feeder sifts-in material to the exact weight desired, and then it is automatically discharged into the container. While sifting is going on in the weigh-and-dump hopper, preliminary weighing operations are being performed in the pre-weigh hopper. All operations of filling, cutting off, discharging, for pre-weighing and final weighing are interlocking.

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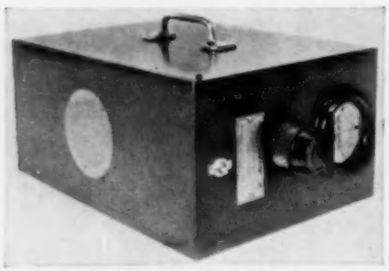
Photo-Electric Color Matcher

Westinghouse Elec. & Mfg. Co.

PORTABLE and comparatively inexpensive, this perfected device for matching colors is arranged to compare samples at 3 points of the visible spectrum without analyzing spectral distribution. It may be used in any position. In general, it is intended to be placed on the samples to be compared or its position reversed so that samples may be placed on the aperture for comparison. Either light or dark samples may be tested, the sensitivity of the unit allowing the matching of even very black surfaces. Brilliantly colored surfaces, however, are within the range of the instrument. Condition of surface—dull or bright—does not cause errors. The power supply is operated from a 110-115 volt, 60 cycle source, though batteries may be substituted. A rectifier tube and filter circuit provide plate and grid voltages for the matching circuit which consists of a low grid current amplifier tube, photo-tube, coupling circuit and sensitivity control. The meter scale has 2 sets of graduations, 0 to 20 with 10 at the center on each, so that it may be read in the usual way or inverted.



The optical system comprises 4 major parts: the lamp, a set of color filters, a lens and mirror, and an integrating chamber. The phototube is the common unit between the optical and electrical systems. The lamp is the standard concentrated filament type and is run at low voltage to insure long life. The 3-color light filter permits comparison at blue, green and red points. The lens and mirror bring the light rays to the sample, and the white integrating chamber brings the rays to the photo-tube, which has a spectral response characteristic such as to give excellent operation with the lamp source. A 3-position color screen permits comparison to be made between a sample and a standard in each of 3 bands of the spectrum, blue, green and red. In comparing a sample with a standard, each band of the color screen is used. Comparison consists of identifying the sample as "lighter," "darker," or "matching" the standard in each band. (Original form described in *Instruments*, Feb. 1932, page 54.)

◆ ◆ ◆

Portable Type Fisher Metallascope

Metallascope Sales Co.

BY using a novel balancing method and circuit design, complete stability is effected in this portable geophysical device adapted for shallow but rapid surveying for pockets and other ore bodies. The forward unit radiates a high-frequency field, half of which penetrates the earth below. When the instrument is carried over ground in which there is metallic ore, pipes (or buried "treasure"), the operator hears a loud signal in the head phones. The action depends on counter-currents induced in the buried metallic body by the high-frequency radiation from the oscillator unit. The field set up by the counter-currents distorts the radiated field. The resulting unbalance shifts the neutral plane away from the receiving loop (rear), thus causing the signal. The response is much greater for metallic bodies which have been buried and in contact with the earth for some time than for newly buried objects. A large ore bed is easily detected, not so much because of the actual amount of metal present but because the metallic particles disseminated through the ore body make it a better conductor than the surrounding matrix. The response of the Metallascope is dependent on this difference in conductivity as well as on the

depth and the size of the object. The intensity of the radiated field falls off approximately with the square of the depth in dry, non-conducting soil. In highly mineralized ground or in water it decreases at a much greater rate. For average conditions, stock model No. 10 has an effective limiting depth of 10 feet and model No. 20 of 20 feet. Special models are available for depths of several hundred feet, but they require expert engineering service and are not readily portable. The 2 stock models weigh 22 lbs. and 27 lbs. respectively. Dimensions are 22" by 52". Units are entirely self-contained.

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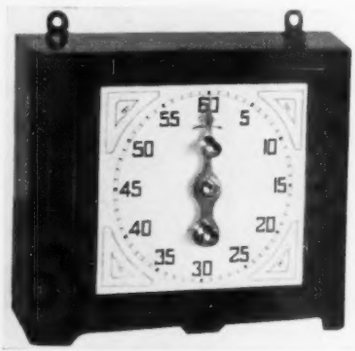
The "Minuteminder"

Walser Automatic Timer Co.

ANNOUNCED as "the simplest and most convenient bell-ringing timer on the market," this clock has a 60-minute maximum range and does not run when not in use. As soon as pointer has been turned clockwise in one movement to desired timing period, clock starts running and drives pointer counter-clockwise. When pointer reaches zero,



bell rings and clock stops. Duration of ringing depends on how far pointer has been turned to right. Thus, to get a long ring (6 seconds) after a timing of only 8 minutes, turn pointer all the way to 55 or 60 and turn it back to 8. The "Minuteminder" can be hung on a wall or used as a bench timer.

◆ ◆ ◆

Photographic Temperature Recorder

Negretti & Zambra

NO one questions the indications of a mercury-in-glass thermometer certified by a government bureau. It is from such a thermometer that the new Photographic Temperature Recorder obtains records on a standard size roll film. The record consists of sharply-defined shadow photographs of the actual thermometer, taken automatically at predetermined intervals. On a film 50" long

the record is of 5 days' duration with hourly intervals, 15 days with 3-hour intervals and one month with 6-hour intervals.

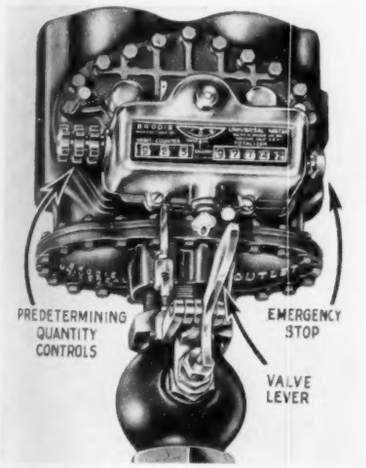
The thermometer is mounted in a slotted frame attached to a light-tight metal box housing a small, short-filament electric bulb. The light from the bulb is collimated by means of a rectangular lens so that a sharp image, free from parallax error, is obtained on the film which comes in actual contact with the graduated face of the thermometer stem. A special type of stem is used, resulting in shadow photographs similar to camera photographs of the thermometer. A special clockwork makes 2 contacts at 1-, 3-, or 6-hour intervals, one contact flashing the lamp, the other subsequently operating a small electric motor which advances the film for the next exposure. Dry cells furnish the requisite energy. The whole is self-contained and capable of being shipped. Crate dimensions, 22" x 18" x 19"; total weight, 100 lbs. Principal application, refrigerator cars and shipholds; reason, legal evidence value of records.

◆ ◆ ◆

Pre-determined Volume Liquid Meter Device

Ralph N. Brodie Co.

AUTOMATICALLY measuring off any liquid quantity from 1 to 1,000 gallons, the "Brodie Quantrol" makes it possible to load and meter any number of tank-trunk compartments simultaneously. It is said to have exceptional merit when used on "long-hose" fuel oil



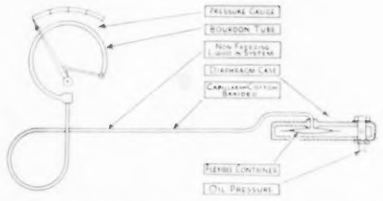
deliveries where the driver must frequently be out of sight or too far away from the metering dials. The "Quantrol" is attached at the outlet of a liquid meter, as illustrated, and is actuated by the operation of the meter.

◆ ◆ ◆

Transmitting Oil Pressure Gage

Negretti & Zambra

IN aircraft and other applications exposed to cold, oil pressure gages become altogether unreliable when the oil in the gage line "freezes." This new instrument employs a non-freezing liquid in the capillary between the Bourdon



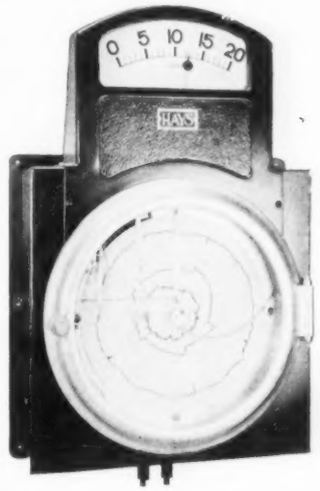
spring and the ingenious diaphragm case (which is bolted directly to the oil pump case by means of a special hollow stud). The principle is apparent from the diagram. Not only does the gage indicate at all times the true pressure in the oil pump, but if the capillary should break there would be no loss of oil as the flexible container would simply collapse on itself and seal off the oil.

◆ ◆ ◆

CO_2 Recorder-Indicator

The Hays Corp.

REMOTE mounting minimizes lag in the operation of this new combustion equipment, its CO_2 analyzer section being located near where the soot filter extends into the last pass of the boiler, while the instrument is placed wherever the fireman can best see it. The Orsat principle is used, a continuous stream of flue gas being drawn rapidly and samples being automatically analyzed at regular intervals. Recording pen and indicating pointer hold their positions after each analysis, changing only when the CO_2 content of the flue gases changes. In addition to the CO_2 recorder-indicator, the manufacturers announce also a 3-pen instrument (illustrated) which records overfire draft and flue-gas temperature on the same 10" chart with the CO_2 record.



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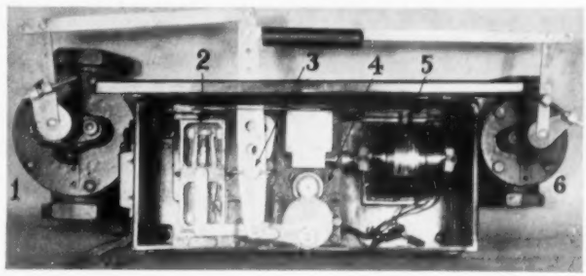
Multi-Position Temperature Control Device

Automatic Temperature Control Co., Inc.

CONTROLLING the temperature of an industrial process where the heat requirement is subject to wide variations, over varying periods, is a problem often presenting major difficulties. Designed on a correct principle, the new Type 305 unit is to be actuated by an intrument having 5 separate contacts—2 either side of the normal setting, or the equivalent, which can be obtained through the use of available relays. Through a simple, positive limit switch arrangement, each intermediate contact between extreme low and extreme high contact in the actuating instrument has 2 definite valve positions, so that on making one of these contacts, following a drop in temperature, the valve opening (and hence the resultant fuel supply) is greater than when the same contact is made following a rise in temperature. With this control system, it is possible to assure a fuel supply more consistent with the fuel demand. Type 305 is practically independent of time lag conditions and is therefore able to make the necessary adjustments to keep a furnace within narrow limits of the control setting under changing conditions of time lag. With this unit, it is possible to get close control without "hunting," when the valves are set for a much wider operating range than is practical with other multi-position controllers. It thus fills a gap between the conventional 2- or 3-position controller and the complete balancing controller. It will function as a unit one or more valves, a damper, rheostat or other regulating equipment to one of 2, 3, 4, 5 or 6 predetermined and adjustable positions. Fuel and air valves having similar flow characteristics and individual maximum and minimum adjustments can be provided for use with Type 305 Controller. With valve openings set for desired fuel-air ratio, this ratio is maintained throughout complete travel of the valves which operate simultaneously and in unison without springs or lost motion linkage. Our illustration shows a Type 305 unit with 2 valves. The units are made in 3 sizes with rated pull, at end of main operating lever, of 30 lbs., 125 lbs. and 200 lbs. respectively, the motor h.p. being 1/30, 1/15 and 1/10. A useful feature is the ability to remove the fulcrum stud, thus permitting the attendant to move the main operating lever with attached valves to any desired position. This is convenient when starting up a furnace, and makes optional the need for by-pass piping and valves for the air line.

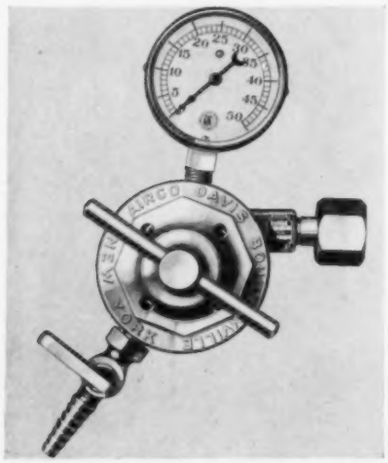


1—Air Valve; 2—Control Switch; 3—Selective Fulcrum Stud, Main Operating Lever; 4—Reduction Gear Unit; 5—Reversible Motor; 6—Fuel Valve.

CO_2 Regulators for Beer Dispensing

Air Reduction Sales Co.

IN the extensive research program which led to the development of this new "8500 Series" CO_2 Regulator, the primary aim was to combine excellent regulating characteristics with minimization of maintenance costs. Correct regulation is obtained by departing from previous practice in the following respects: The valve action is controlled by a self-damping lever; and the high-pressure passages minimize "pre-cooling," thereby eliminating sudden variations under normal operating conditions. The main causes of regulator valve seat failure have been eliminated through the use of a fine glass wool dust filter in the inlet, and of new principles for ensuring seat alignment and accommodation. Strong forgings give ruggedness to the simple pressure control mechanism. A dependable safety valve protects the regulator against accidental excessive pressures. Outlet cut-off cocks (1 or 2) may be closed when the regulator is not in use so as to prevent beer and foreign materials from being forced back into the regulator. With two outlet cocks, the new regulator may be employed for simultaneously supplying the pressure for two barrels.



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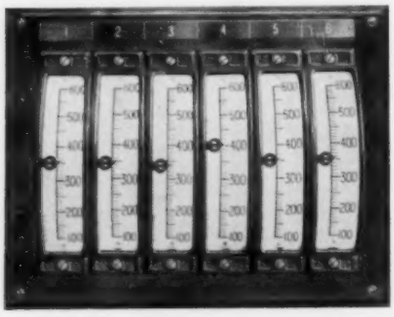
Edgewise Thermometer

Negretti & Zambra

WITH its "vertical-edgewise" case 9" high and 2¼" wide, this new instrument combines easy reading and compactness. The thermal system is mercury-in-steel, with heat-resisting steel bulb permitting the measurement of temperatures up to 1200° F., and center acting coil spring. Principal application, Diesel engine exhaust temperatures, the illustration showing the arrangement of 6 thermometers, the pointers of which are all in a horizontal line when the 6-cylinder engine is working properly.



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Junior Model Hellige-Duboscq Colorimeter

Hellige, Inc.

AT first glance this new instrument appears to be a colorimeter of the Duboscq pattern but of unusually small size. The real novelty, however, consists in having the cups move simultaneously in opposite directions. It no longer is necessary to set the solutions in cups at any particular liquid depth; in fact the scale is not even graduated in mm. and fractions but in divisions which show the ratio of the 2 liquid depths, from which the concentration of the unknown can be read directly in terms of the known. Not only are computation errors eliminated but the proper liquid depth in *both* colorimeter cups is adjusted in a moment. The pinion is placed between 2 racks (one for each cup platform) and this mechanical balance makes for smooth operation, delicate balancing of the color fields and exact adjustment of the liquid columns. The one-piece type prism has been newly designed throughout and the new optical system has no absorbing cement or reflecting silver layers in either of the 2 light paths. The dividing line of the half-fields is invisible when properly focused. Judging from the long list of accessories, this "junior" model can be used for quite a great number of different purposes.

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X-Ray Fibre Spectrograph

Adam Hilger, Ltd.

DESIGNED by W. T. Astbury, B.A., Textile Research Dep't, Univ. of Leeds, this new instrument makes possible the study of the behavior of all types of fibres, e.g. wool, silk, cotton, hair, etc., under a variety of conditions, such as tension and humidity, thus yielding important information on the effects of processing or of wear upon textile materials. With its accessories it provides a complete equipment for X-ray fibre research. The stand is fitted with an engraved stainless steel triangular bar (1) on which are mounted the camera holder (6), X-ray collimator (3) with interchangeable apertures (10) and adjustable centering pin (2) for which a protective cap (9) is provided. A subsidiary stainless steel bar (4) with bracket (5) attached is provided for mounting the various accessories. X-ray photographs may be taken on either plates or films, as both types of cameras (7) are provided. A rotatable sector device (8) that can be fitted to the camera enables comparison photographs to be made. This is necessary for detecting very small changes in the fibre lattice. The accessories supplied include: a lead collimator shield (13); radiation filter holder (14); and a set of collimating apertures (10); also the following not illustrated:

Large lead screen for shielding cameras from scattered X-radiation. 12 winding washers for fibres; mount for holding washers during winding; large fibre tension frame with long adjusting handle; table mounting for large tension frame; small tension frame for hand winding; tilting mount for setting fibres at any desired angle to incident beam (0-40°); compression frame for enabling exposures to be made parallel to fibre axis; 2 drying chambers for use with fibres when photographed (a) in normal position and (b) parallel to the axis; 2 attachments for (a) treating fibres with acids, etc., and (b) for spraying fibres with steam during exposures; and holder and tensioning frame for very fine fibres (such as spider's web).

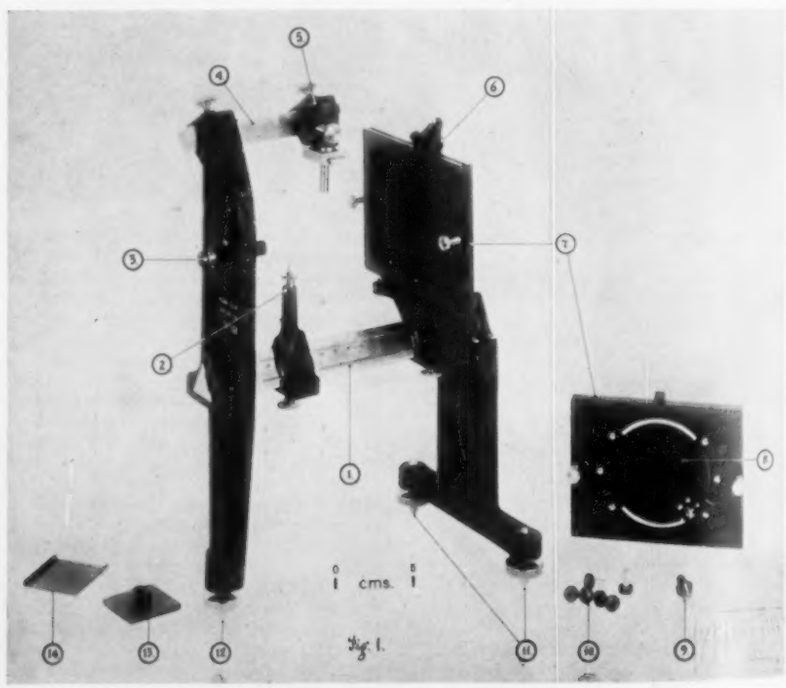

Fig. 1.

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Modern Brewery Instrumentation

(Continued from Page 154)

processes. The temperature of the hop storage room is important and some breweries use a recording thermometer there. Electrical instruments may be used to check up motor operation. Automatic counters are used to count cases on the belt conveyor. In addition to all instruments used in the operation of the plant there are those which the laboratory requires, which includes standards for checking thermometers, hydrometers, and pressure gages.

Brewers in resuming operation after 13 years find themselves confronted with conditions somewhat changed. Their product is very heavily taxed, therefore in order to sell it at a popular price it becomes necessary to keep down the cost of manufacture. It appears that the public is going to be very discriminating in its preferences, and with competition very keen it will be necessary not only to make good beer but make it uniformly good. *Economy* in cost of production and *uniformity* of the product must therefore be the brewer's goal. These requirements also exist in every food industry. Some of the methods and equipment that have been developed in the past 13 years for other food industries will be of value to the brewing industry. Instruments have played an important part with most food industries and the breweries will find many new instrument developments available to them. With their traditions of seeking the best equipment they will take advantage of the best of today.

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An Interesting Set of Antique Weights

—now in the possession of C. Fred Sauereisen, president of the Technical Products Co., of Pittsburgh, was brought to this country from Germany where his grandfather, a practicing physician in Jena, used it. The weights are of brass, cup-shaped to nest within one another and within the brass case of pleasing design. The unit of measurement is equal to approximately 17.5 grams. The set comprises an 8, 4, 2, 1, ½, ¼, ⅛ and $\frac{1}{16}$, while the empty case itself weighs exactly 16 of these units. *Markings:* on each weight, a coat of arms; on the case a cannon (probably the brass founder's hall-mark) and the symbol shown in the corner of our illustration.

◆ ◆ ◆

Regulator Companies Change Name

The Mason Regulator Co., of Boston, and the Neilan Co., Ltd., of Los Angeles (subsidiary of the Mason Co.), have consolidated. The name of the new company is the Mason-Neilan Regulator Co. The engineering, manufacturing and sales departments of the individual companies have been combined at 1190 Adams Street, Boston. F. K. Morrison, former sales manager of the Mason Regulator Co., and Dougles H. Annin, chief engineer of the Neilan Co. for several years, will both continue in similar positions in the new company.

This union brings under the Mason-Neilan trade mark a complete line of pressure and liquid level regulators as well as compensated instruments for controlling pressures, temperatures, rates-of-flow and combustion.

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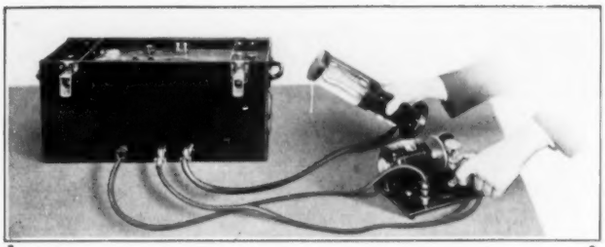

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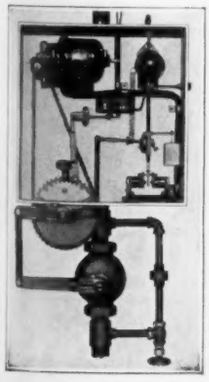

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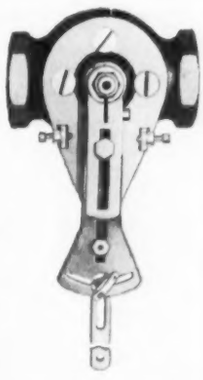
At the left is the plain type made up with by-pass and mounted in a vertical pipe line with a Defender Model B electric pressure regulator strapped onto a vertical pipe line and operating the lever on the Chronometer Valve. This Electric Control can be supplied to operate from pressure, temperature, vacuum, etc. and is by far the most sensitive small-size quick-acting regulator made. Agents wanted everywhere.



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